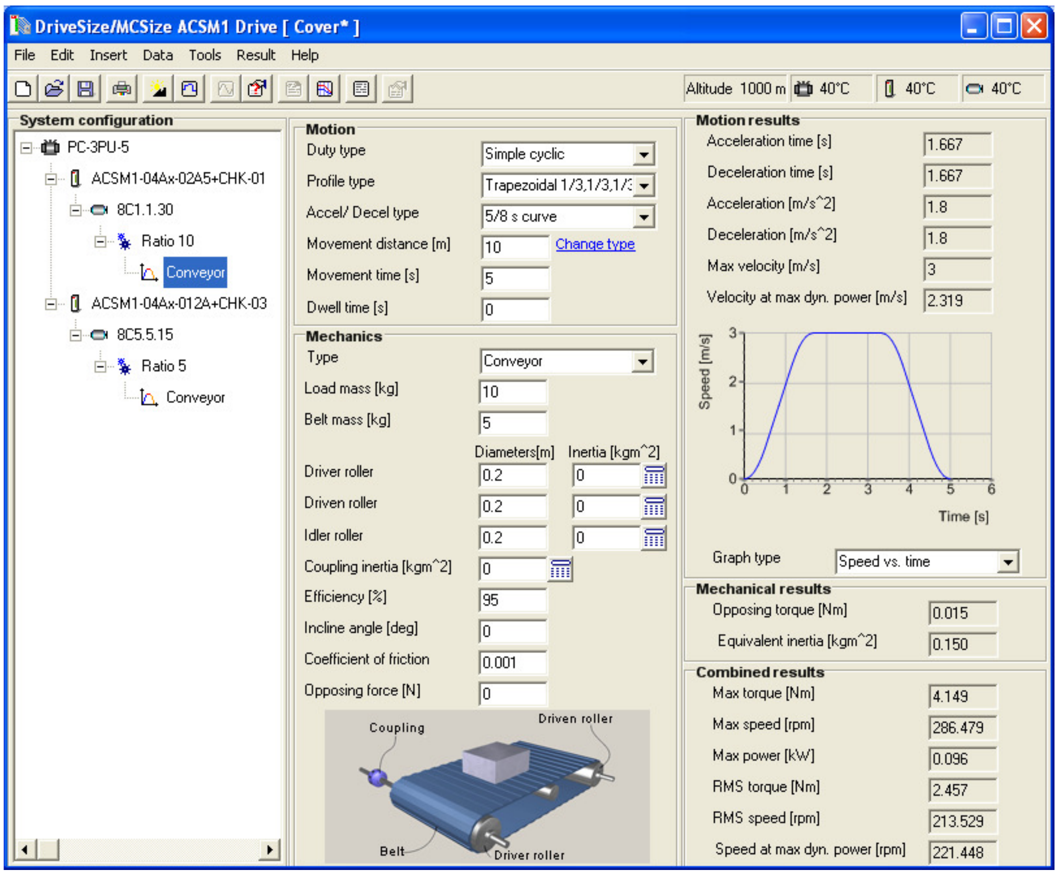
Drive*Ware*® **User Manual**

MCSize



MCSize

User Manual

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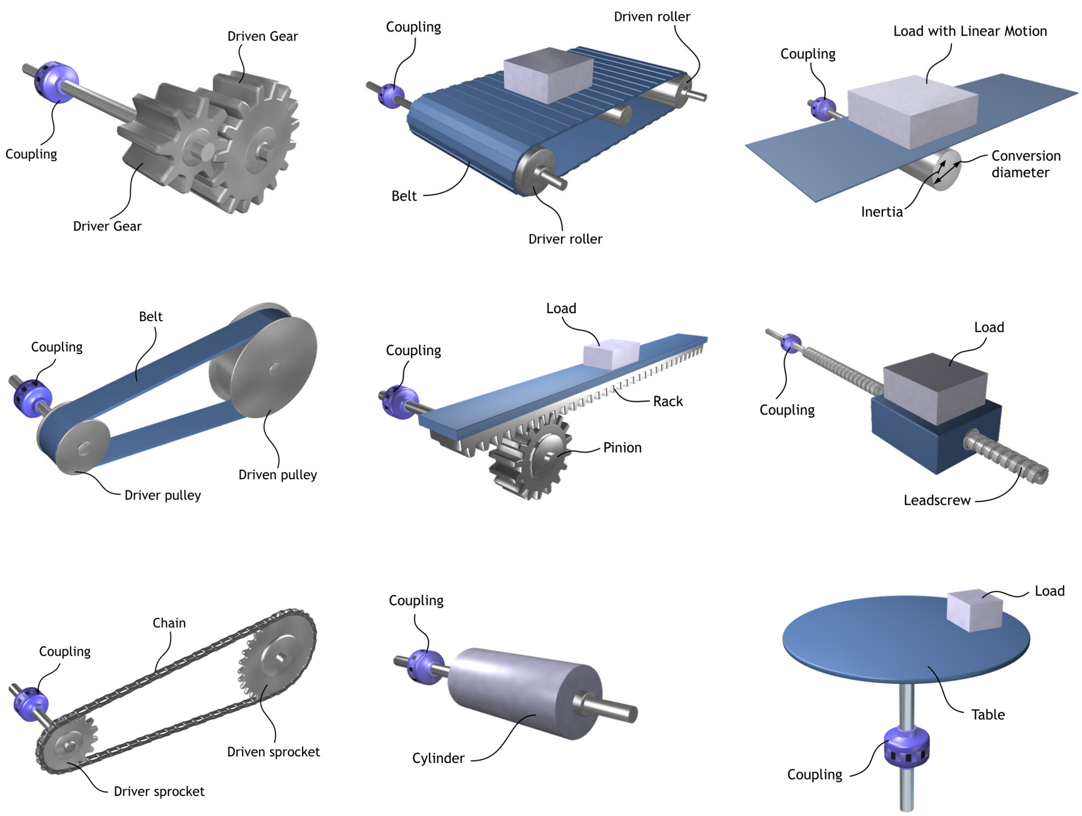
1 About this manual

1.1 Overview

This manual gives you instructions on how to use the MCSize sizing tool. The main principles of operation are also explained. The manual is targeted to machine designers and anyone who needs to select electrical drive system components or wants learn how to select them. The manual is also available as an online help file.



1.2 Document conventions

The following table lists the terms and conventions used in this manual.

Table 1. Terms, conventions and abbreviations used in this manual

Term or abbreviation	**Explanation**
Sizing, dimensioning	Calculation of the correct size of the parts in a frequency converter assembly
IC	International Cooling
IP	International Protection
RMS	Root mean squared

2 Overview of MCSize

2.1 General

The name MCSize refers to motion control and machinery drives and the MCSize software is meant to be a fast technical computing tool for all users who need to select electrical drive system components. Typically a sizing process starts from the selection of mechanics and motion profiles. Also gears are an essential part of the system. Because the automatic gear ratio optimization is not currently included in the software, users are expected to use their common knowledge when setting the gear ratios, since it is an important part of cost effective solutions.

The motor selection is based on technical facts only, usually on the torque requirements of the motion and mechanics. MCSize does not contain cost or price information and, thus, cost optimizing has to be performed manually. After the calculation of choices the frequency converter – also called drive – is then selected on the basis of motor current function.

The single drive selections and the sizing of line converter with one or several inverters are supported. MCSize is a part of the DriveSize system and inherits the same principles. To help new users MCSize inserts reasonable default values to the required input fields. This way the users are able to command the software to dimension the motors and drives right away. The software for example gives the default value of 0.2 m for the driver roller of the conveyor, as a value of 0 m would cause the software to give unnecessary error messages about missing data. However, it is easy to override the default values and save new values for future use. In any case, an inexperienced user should read all inputs through before making any decisions.

In addition, MCSize provides plenty of intermediate results for users. This helps the user to:

1. double-check results
2. easily find good and cost-effective solutions
3. use some of the computed data when the drive or motor is started and commissioned with mechanics.

MCSize requires DriveSize 2.7 or a newer version to be installed on the computer. DriveSize also contains the induction motor database. MCSize itself contains the servomotor and frequency converter databases.

MCSize has been tested with the Windows 2000 and Windows XP operating systems.

2.2 Functions

With MCSize you can:

- Compute Torque requirements for various mechanical arrangements

- Compare gearing alternatives
- Select the correct size of a drive and the correct motor combination
- Select a suitable line converter for the regenerative drive system
- Compute the proper braking chopper and resistor
- Compute multiple axis systems
- Export the produced results from MCSize to the .xls format.

2.3 MCSize user interface

2.3.1 Main window

After you have opened or created a project, the main window opens. You can see the layout of the main window in Figure 1.

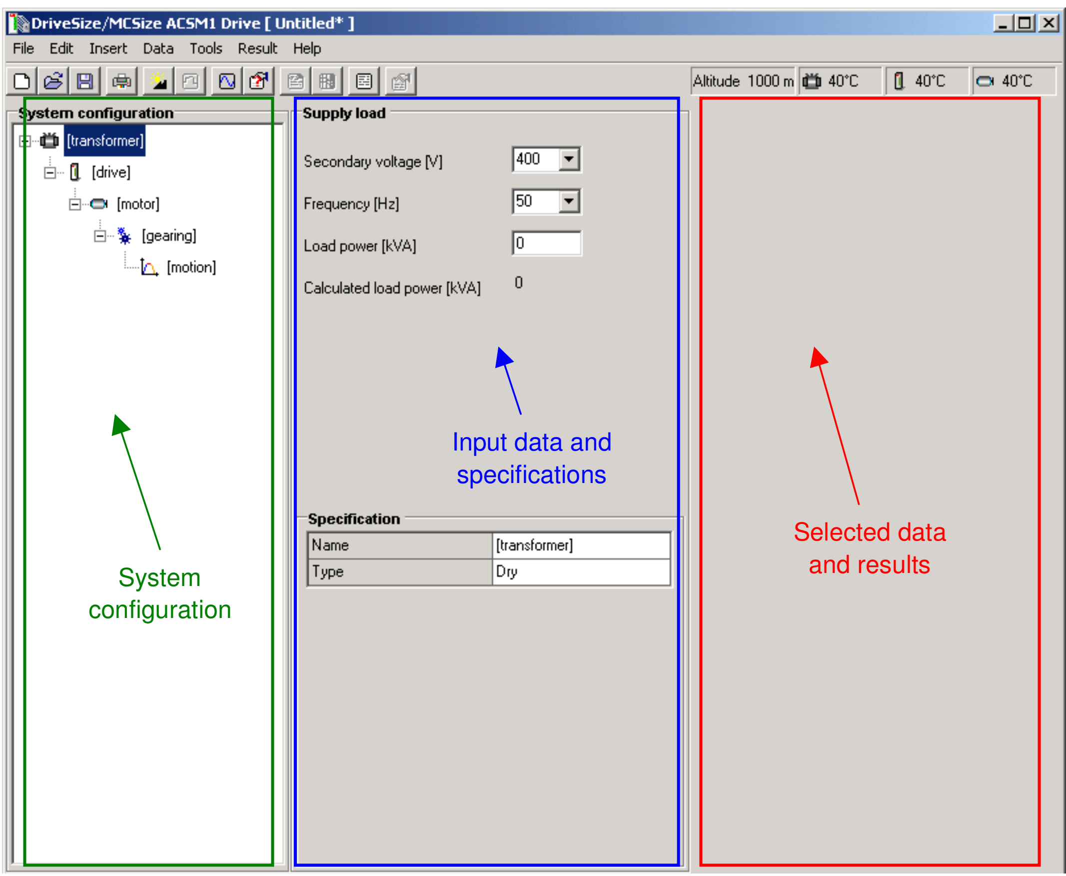


Figure 1. MCSize main window

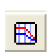
Transformers, line converters, drives, motors, reductions, and motion profiles and mechanics all have their own data input displays. When you click on an item in the **System configuration** tree, the input data display will change accordingly.

2.3.2 Toolbar

The toolbar provides quick access to common functions in MCSize. You can find the functions of the toolbar also in the main menu (see Table 2).

Tip: When you move the cursor over a button the help text for that button appears below it.

Table 2. Toolbar icons

Icon	Action	Menu equivalent
	Opens a new project	**File > New**
	Opens a project	**File > Open**
	Saves the project	**File > Save**
	Opens the **Print** dialog	**File > Print**
	Opens the **Ambient Conditions** display	**Data > Ambient Condition**
	Opens the **Motion profiles** display	**Data >Motion Profile**
	Opens the **Network Check** display	**Tools > Network Check**
	Dimensions the selected item	**Tools > Dimension Unit**
	Opens the dimensioning **Results** display	**Result > Dimensioning Result**
	Opens the **Graph** display	**Result > Graphs**
	Opens the **List selected** display	**Result > Units Selected**
	Opens the **User Selection** display	**Tools > User Selection**

In the upper right corner of the main window you can see the ambient conditions display. The displayed ambient conditions data are described in Table 3.

Table 3. Ambient conditions on the toolbar

Picture	Description
	Indicates the transformer's ambient temperature
	Indicates the drive's ambient temperature

	Indicates the motor’s ambient temperature
	Indicates the installation’s altitude

3 Installing MCSize

3.1 System requirements

To run MCSize, you must have DriveSize installed on your computer. For system requirements, refer to the DriveSize manual. Additionally MS .NET Framework 1.1 or later is required.

3.2 Installation

To start the installation of MCSize:

1. Start Windows.
2. Insert the MCSize CD into the appropriate drive or download the setup package to your local hard disk.
3. Select **Run** from the **Start** menu.
4. Type the drive letter of the drive followed by "**:\MCSize.exe**", for example C:\MCSize.exe. Click **OK** or press **ENTER**.
5. Follow the instructions the installation program gives you.

The software installation copies all the necessary files to the drive and directory specified by the user. The setup program prompts you to install the software to **C:\ProgramFiles\DriveWare\DriveSize**. You can change the directory, if necessary. The set-up program also creates a working directory in **C:\ProgramFiles\DriveWare\DriveSize\Projects** where all of your projects will be stored.

If you have problems installing MCSize, close any other active programs. Restart Windows and do not open any programs before the installation is completed. Always disable MCAfee Host Intrusion Prevention System (HIPS) both while installing and uninstalling.

Before reinstalling, uninstall the old version of MCSize.

3.3 Uninstalling

To uninstall MCSize:

1. Select **Start > Settings > Control panel**.
2. Double click **Add or remove programs**.
3. Select the MCSize software from the list and click **Remove**.

4 Starting a project

4.1 Opening new project

In the DriveSize **Welcome** screen, double click the ACSM1 Drives (MCSize) icon or click **Open** from the **New** project selection tab (See Figure 2).

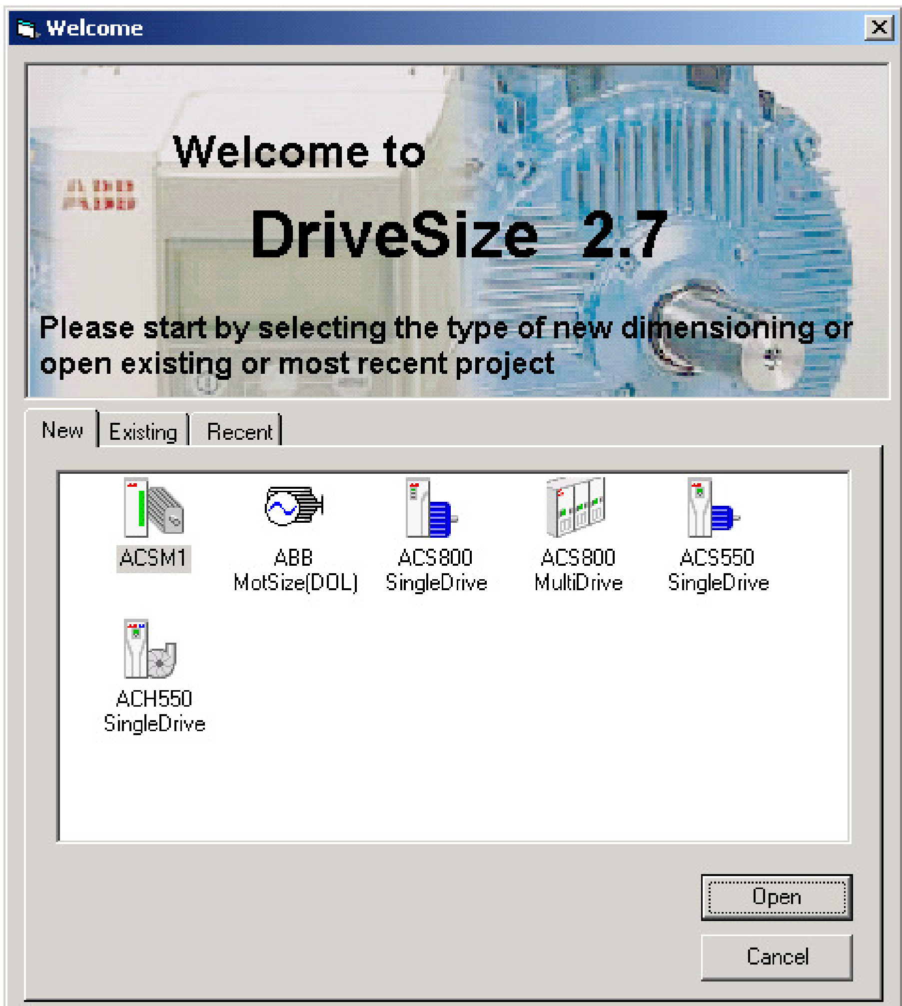


Figure 2. DriveSize Welcome window

On the tabs **Existing** and **Recent** you can open projects saved earlier.

First Drive Type dialog opens for a start. Select the type of drive you want to start with. There is possibility to add single drives and regenerative drives to the same project. It is possible to convert single drive to line converter supplied unit too.

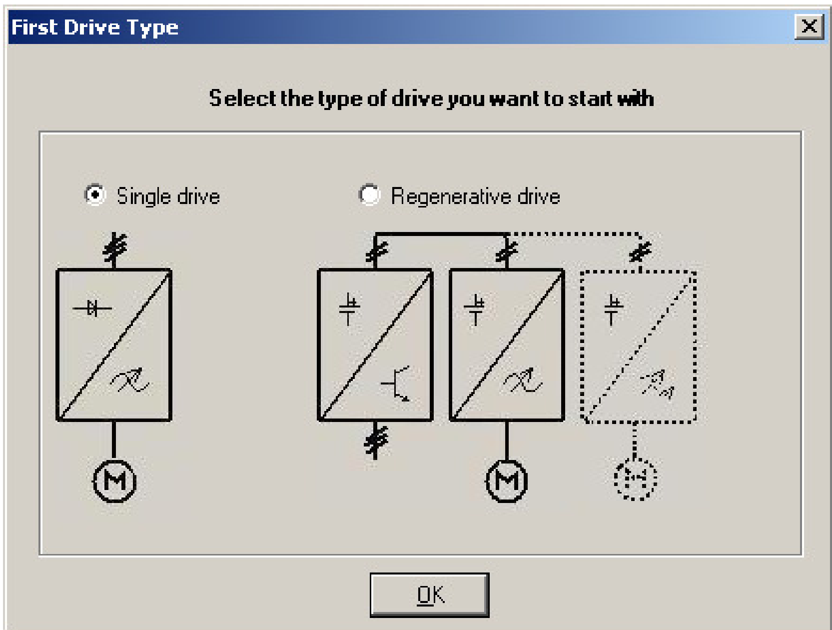


Figure 3. First Drive Type dialog box

4.1.1 Changing project information

To open the **Project information** window (see Figure 4), select **File > Project Info...**.

Enter new project data. MCSize saves this information when you save your project and includes it in your reports. Click **OK** to save the project information or **Cancel** to discard the changes.

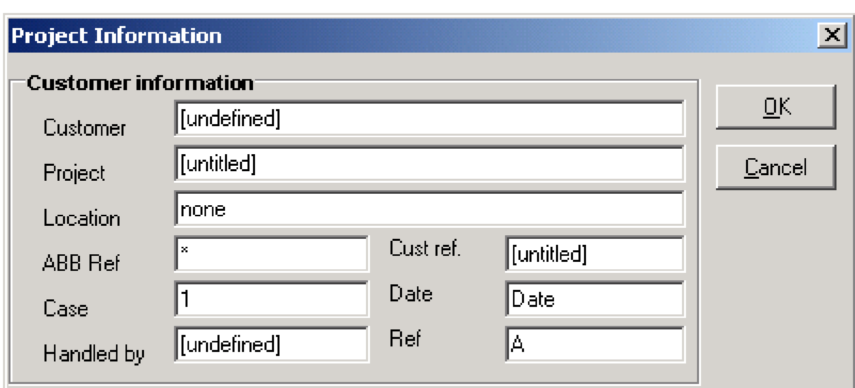


Figure 4. Project information window

4.1.2 Selecting ambient conditions

To open the **Ambient conditions** dialog (see Figure 5), click the toolbar icon or select **Data > Ambient Condition**.

Type new data to the appropriate text boxes to change the ambient conditions. The practical range for altitude is between 1000m and 4000m.

Note: The altitude's dependency to the load capacity is different with different components. The practical range of ambient temperature is usually from 30°C to 50°C. This also changes according to the component. For example, a temperature up to 55°C is acceptable for ACSM1 drives.

Click **OK** to save the ambient conditions information or **Cancel** to discard the changes.

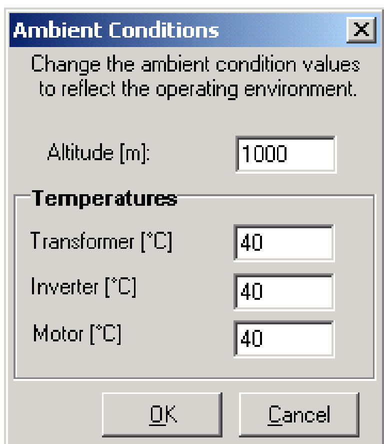


Figure 5. Ambient conditions window

4.2 Creating new project file

To create a new project file, use one of the following three methods:

- Click the toolbar icon
- Select **File > New** from the menu, or
- Press the **Ctrl+N** short cut key

The name of any new project file is "Untitled" until you change it. You can change the project name when you save the project.

4.3 Saving project file

To save the project file:

1. Click the icon, or Select **File > Save**.

2. For new projects select a location and type in a name for the project.

4.4 Opening saved project

To open a saved project:

1. Click the  icon or select **File > Open**.
2. Select the project file and click **OK**.

The ACSM1 motion control project files have a unique file extension. Select the correct extension option (.mdd) from the **List of file Types** to open these files.

5 Sizing

5.1 Sizing procedure overview

5.1.1 System configuration tree

The **System configuration** tree displays an overview of the frequency converter system as well as the type designations or names of units in the tree format (see Figure 6). MCSize includes different data input displays for the transformer, supply, drive, motor, gearings, and motion profile and mechanics data. When you click on an item in the **System configuration** tree, the input data display will change accordingly.

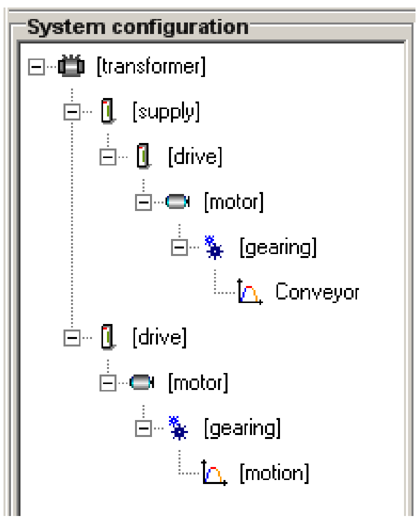


Figure 6. *System configuration tree*

The **System configuration** tree includes the following icons:

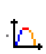
 Transformer

 Supply (when regenerative drive)

 Drive

 Motor

 Gearing

 Motion profile and mechanics

5.1.2 Order of selections

Dimensioning selections can be performed for example in the following logical order:

1. Select a **Secondary voltage [V]** for the system.
2. Select the **Frequency [Hz]** setting.
3. Select the type of application.
4. Enter motion profile input data.
5. Specify application data for mechanics.
6. Select gearings and enter input data.
7. Select motor specifications and motor sizing.
8. Select drive specifications and sizing.
9. Select supply specifications and sizing (when regenerative drive)

To add a second axis, select **Insert > Drive + Motor +Mechanics** or **Insert > Supply + Drive + Motor +Mechanics** from the menu bar and repeat the selections from 3 to 9.

However, MCSize allows you to select and modify units at any level, and you can perform the dimensioning selections in any order. For example, you can easily change the supply voltage and frequency at any stage.

5.2 Transformer data

5.2.1 Entering transformer data

To modify transformer input data, open the transformer display (see Figure 7) by selecting the **Transformer** icon from the **System configuration** tree.

To modify transformer data:

1. Select the **Secondary voltage [V]** setting from the drop-down list.
2. The default **Frequency [Hz]** setting is 50Hz but you can change it to 60Hz if valid.
3. MCSize also displays the **Calculated load power [kVA]**, which you may override by typing a value for **Load power [kVA]**. This will affect the transformer selection.

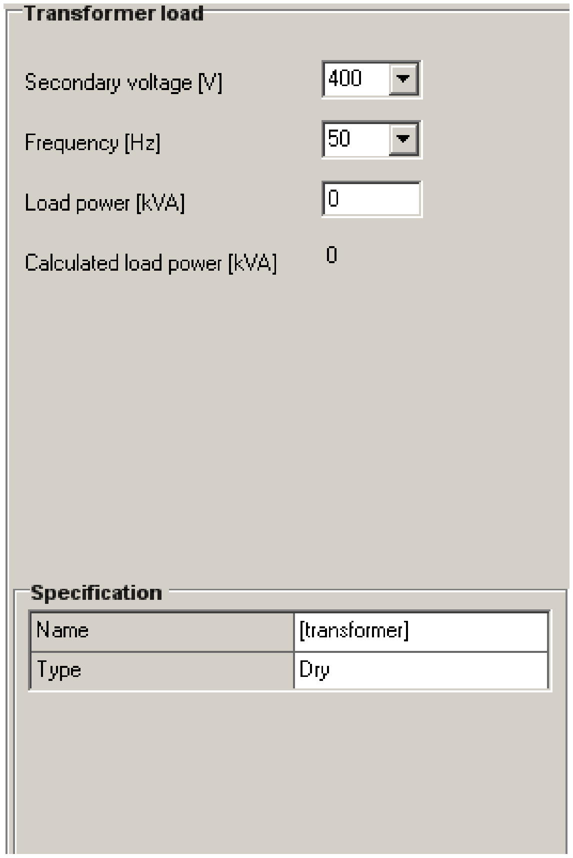


Figure 7. *Transformer load data definition*

5.2.2 Modifying transformer specifications

Insert data in the **Specification** field of the **Transformer load** display.

You can see the input fields for transformer load specifications in Table 4.

Table 4. *Transformer load specifications*

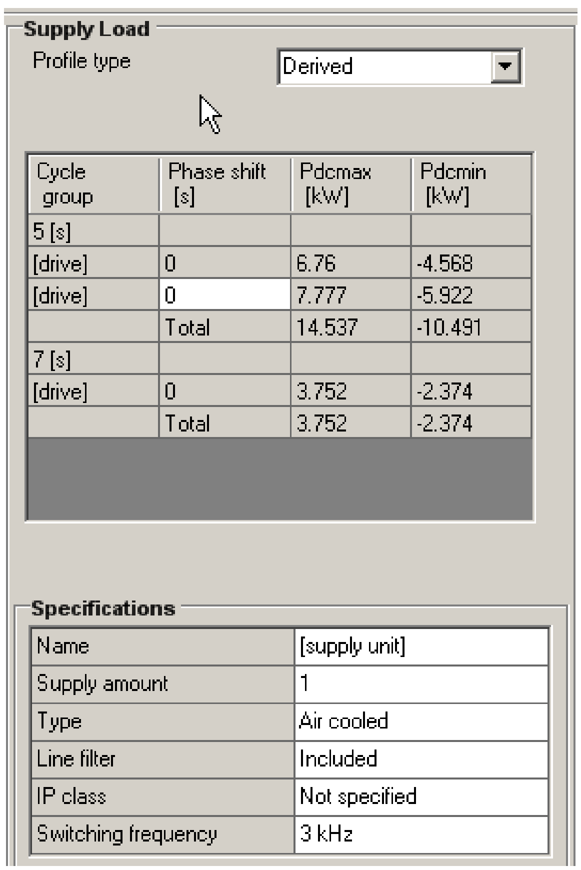
Specification	Options
Name	Any text or number string. This will also show up in reports and, depending on the **Tools**/**Options** settings, on screen.
Type	Dry, Oil

5.3 Supply input data

To enter supply load data, open the Supply load display (see Figure 8) by clicking the **Supply icon** in the **System configuration** tree.

5.3.1 Profile type

Two **Profile type** options are available. One for **Manual** load entering and another for **Derived** load. Derived load means that load is calculated based on mechanics connected to that regenerative supply unit. The loads that have identical cycle time are collected to own groups. It is also possible to define phase shift between loads with same cycle time (see Figure 8).



Cycle group	Phase shift [s]	Pdcmax [kW]	Pdcmin [kW]
5 [s]			
[drive]	0	6.76	-4.568
[drive]	0	7.777	-5.922
	Total	14.537	-10.491
7 [s]			
[drive]	0	3.752	-2.374
	Total	3.752	-2.374

Name	[supply unit]
Supply amount	1
Type	Air cooled
Line filter	Included
IP class	Not specified
Switching frequency	3 kHz

Figure 8. Supply data definition

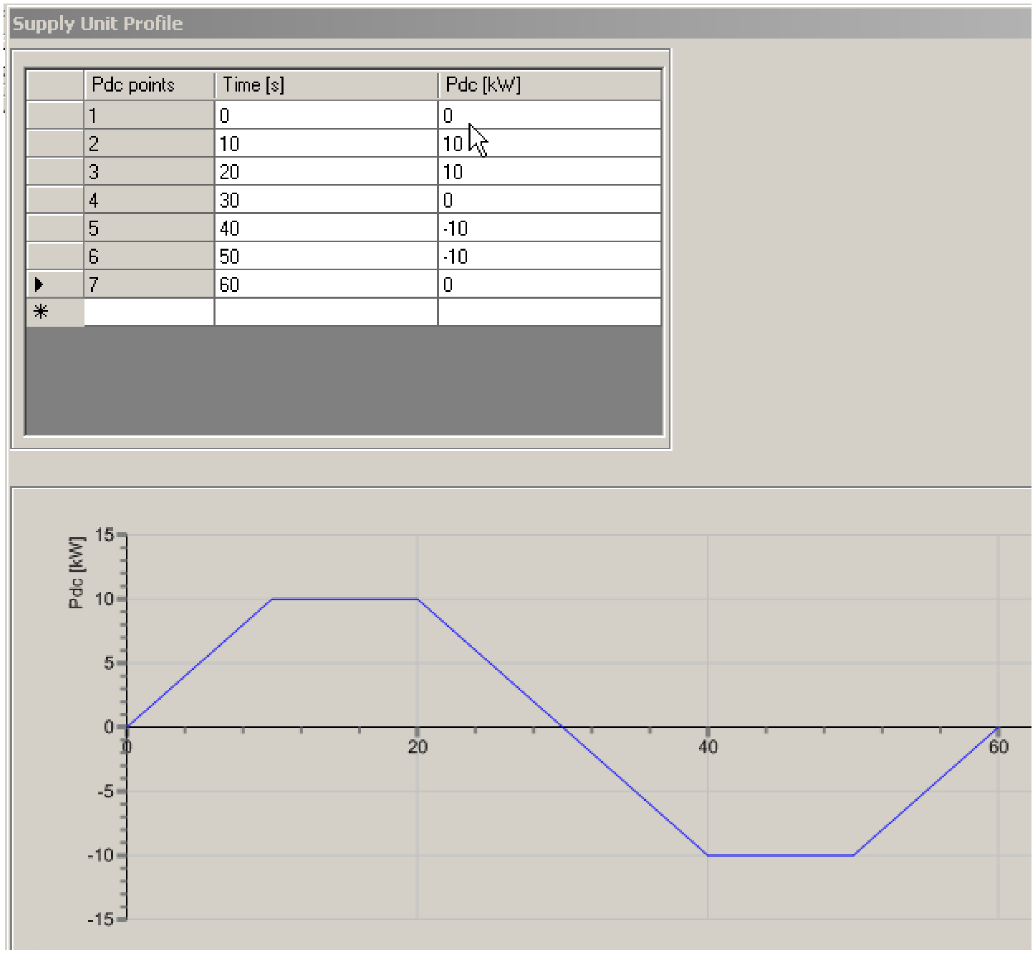


Figure 9. Manual supply data definition

Select manual profile option to enter load manually. These inputs override the load calculated on mechanical load. When manual profile is selected then **Supply Unit Profile** view opens (see Figure 9).

Manual can consists on up to 50 load points.

5.3.2 Modifying supply specifications

You can set the following specifications for the regenerative supply: Line converter amount, type, line filter, IP class and switching frequency. To modify drive specifications, click on the desired item. Select new values from the drop-down lists or type the new value to the field.

You can see the input fields for drive load specifications in Table 5.

Table 5. Supply unit load specifications

Specification	**Options**
Name	Any text or number string. This will also show up in reports and, depending on the **Tools**/**Options** settings, on screen.
Supply amount	Number of similar drives with range 1 – 100 for one branch in the **System configuration** tree
Type	Air cooled, Cold plate
Line filter	Included
IP class	Not specified IP20 – This selection means that the user is specifically limiting the choices to the IP20 protection class.
Switching frequency	3, 4, 5, 8 or 16 kHz

5.4 Drive input data

5.4.1 Entering drive load data

To enter drive load data, open the **Drive load** display (see Figure 10) by clicking the **Drive icon** in the **System configuration** tree. White fields are editable and grey fields are calculated on the basis of profile, mechanics, gearings, and motor input data. The calculated values include primarily dimensioning criteria. However, drive load inputs are optional and they override the calculated values.

The inverter is loaded with the calculated motor currents, frequency and power factor.

You can change the motor currents. Enter new values to editable fields for each segment. These values override the calculated values. Note that all the other motor data and the given speed profile will still be used. In Table 6 you can see the explanations of abbreviations that are used on the display.

Table 6. Explanation of abbreviations in Drive load display settings

Abbreviation	**Meaning**
RMS-current	Root mean squared value for the whole duty cycle currents
Max-current	The calculated peak value that occurs during the duty cycle

5.4.2 More complicated inverter profile

The text **custom** is shown in Drive load display's current and duration fields when the Duty type of motion profile is Multiform cyclic. Open **Inverter profile** to see the segmental currents. You can also enter the new current for each segment and these values override the calculated values. All the other motor data and the given speed profile will still be used.

Click the icon, or select **Data > Motion profile** from the menu to open Inverter profile**.**

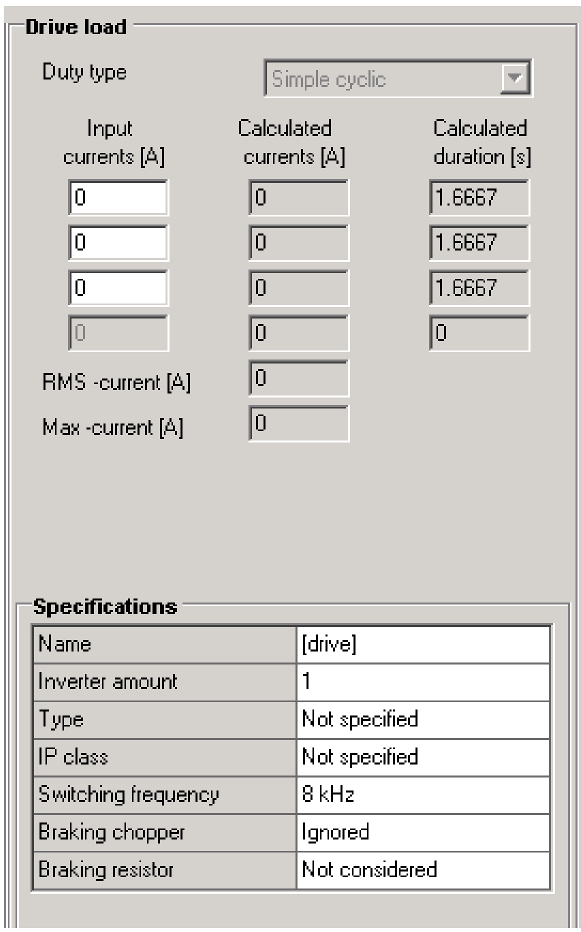


Figure 10. Drive load input data

5.4.3 Modifying drive specifications

You can set the following specifications for the drive: the inverter amount, type, IP class, switching frequency, braking chopper and resistor.

To modify drive specifications, click on the desired item. Select new values from the drop-down lists or type the new value to the field.

You can see the input fields for drive load specifications in Table 7.

Table 7. Drive load specifications

Specification	**Options**
Name	Any text or number string. This will also show up in reports and, depending on the **Tools**/**Options** settings, on screen.
Inverter amount	Number of similar drives with range 1 – 100 for one branch in the **System configuration** tree
Type	Air cooled, Cold plate
IP class	Not specified IP20 – This selection means that the user is specifically limiting the choices to the IP20 protection class.
Switching frequency	4, 8, 16 kHz. Higher switching frequency will reduce the audible noise and give better motor performance, but will adversely cause losses in the drive and the max current providing capability.
Braking chopper	Ignored – This selection means that even though the internal chopper is used, the losses of it are anyway ignored when a drive selection is performed. Internal – This selection means that the losses of internal chopper are added to drive losses and the limitations of the internal chopper are considered when selecting a drive.
Braking resistor	Not considered – The braking resistor is not selected this time. Selected – The braking resistor is selected on the basis of the motion duty braking power requirements.

5.5 Motor input data

5.5.1 Entering motor load data

Open the **Motor load** display (see Figure 11) by clicking the **Motor** icon in the **System configuration** tree. The calculated values are shown in grey fields. To enter optional motor load data, fill in at least one value.

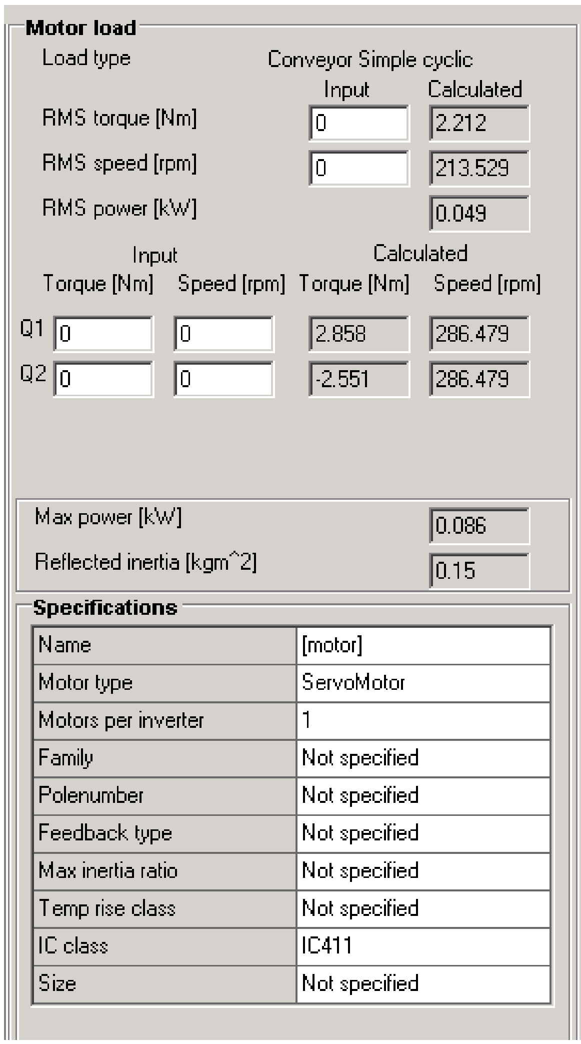


Figure 11. Motor load input data

Input fields are editable and calculated values are based on profile, mechanics and gearings. The calculated values include primarily dimensioning criteria, but motor load inputs are optional and they override the calculated values. The calculated torque is a peak torque at motor shaft and in the final results the motor inertia is also taken into account. The calculated speed is the speed at the max dynamical

power or the speed when the calculated peak torque really exists. Only the quadrants that really exist in the mechanical application are shown in the motor input load view. You can see the definitions of quadrants in Table 8.

Table 8. The definition of quadrants

Quadrant	**Description**
Q1	Positive torque, positive speed
Q2	Negative torque, positive speed
Q3	Negative torque, negative speed
Q4	Positive torque, negative speed

5.5.2 Modifying motor load specifications

You can see the input fields for motor load specifications in Table 9. Note that some of the input fields are dependent on the selection made in the Motor type field.

Table 9. Motor load specifications

Specification	**Options**
Name	Any text or string
Motor type	ServoMotor – Permanent magnet servo motors in database, InductionMotor – ABB's catalog induction motor, ExistingServoMotor – Enter motor characteristics case-by-case, ExistingInductionMotor – Enter induction motor characteristics. UserDefinedServoMotors
Motors per inverter	Normally 1, but can be in the range 1 – 100 similar motors per an inverter unit. The load is given for one motor. One inverter feeds several motors connected in parallel.
Family	According to the **Motor type** selection, the motor family choices are shown. If you have no preferences, use “Not specified”.
Polenumber	Not specified, 2, 4, 6, 8, 10, 12
Feedback type	Not specified, Encoder, Resolver – With servomotors an encoder motor might give less output than a resolver motor because resolver motors withstands higher temperatures.
Max inertia ratio	Not specified, 2, 3, 4, 10, 100. Read the text below this table.
Temp rise class	Not specified, B [< 80K], F [<105K]. **Not specified** means that MCSize will use

	the class given in motor catalogs.
IC Class	Not specified, IC-0041, IC411, IC416. **IC-0041** = enclosed motor without cooling fan. **IC411** = cooling fan on motor shaft; means lower loadability at partial speeds. **IC416** = separate cooling fan. Choose this option for constant torque cases where the min speed is very low. For large motors there are other choices available.
Size	If specified, limits the selection to the particular shaft height of induction motor or the size code of servomotor.
Auxiliary brake	No brake, Holding Affects to the inertia of motor
Max speed rule	Standard, Metal fan Available only for Induction Motors
Motor Tmax margin	43%, 20% Available only for Induction Motors

In inertia calculations, the inertia ratio corresponds to the reflected inertia divided by the motor inertia. You can set the maximum acceptable value for this ratio. The ratio will be the motor selection criterion. The ideal ratio for reflected inertia to motor inertia is 1:1, a ratio that yields the best positioning and accuracy. The reflected inertia should not exceed the motor inertia more than tenfold, if it is important to maintain the control performance.

Motor selection criteria are also based on system voltage which is given as the **Supply voltage, Frequency** and **Switching frequency** of the drive.

Catalog induction motors will have the same nominal frequency as the supply, and a nominal voltage similar to the system voltage. The switching frequency of a drive does not affect the thermal behavior of a motor within MCSize. The output voltage of a drive at a field weakening area is less than the system voltage, and this is taken into account when the maximum short term torque curve is drawn. You will notice this from the fact that the turning point of the curve is not exactly at the level of nominal frequency but below it.

On the other hand, the permanent magnet servomotors have non-standard nominal voltages and they are always lower than the system voltage. When overloaded at higher speeds, the motor voltage will be higher than the nominal voltage but anyhow lower than the system voltage. Some reserve voltage has to be available for the good performance of drives. The nominal values of servomotors are given with a switching frequency included in the database. If the setting of drive switching frequency is lower, the nominal values of servomotors must be scaled down. If the drive switching frequency is higher than the motor’s switching frequency, the

motor's nominal values are kept in the original values. The best thermal characteristics for a motor are achieved with the highest drive switching frequency.

The system voltage also affects the servomotor maximum speed and available short-term torque at high speeds. You will notice this by changing the system voltage, for example, from 380V to 400V or 415V, and by monitoring the short-term torque of the same motor.

Notice: Stall torque allowing 30 seconds at zero speed in maximum.

If you select **ExistingServoMotor** or **ExistingInductionMotor** in the **Motor type** field, the **Existing motor** window opens. You can see the input fields for existing motor specifications for **ExistingServoMotor** in Table 10. You can see the definition of loadability curve in Figure 12. Ensure that the motor data are valid for the same switching frequency that you are going to select from the drive specifications.

Table 10. Existing motors specifications for Existing Servo Motor.

Specification	Options
Type designation	Any text or string
Voltage [V]	400
Frequency [Hz]	50
Power [kW]	0.62
Poles	2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Speed [rpm]	1500
Efficiency [%]	90
IC class	IC410
Temp. rise class	B[<80K], F[<105K]
Mcs	3,9
Mn	3,9
Mp0	14
Mp1	14
Mp2	14
n1	1500
n2	1500
n3	6000
Kt	3.04
Inertia [Kgm^2]	0,001
Luv [H]	0.004
Ruv [ohm]	2
Back EMF [V]	190

Where Kt is torque constant [Nm/A], Luv is line-to-line armature inductance [H] and Ruv is line-to-line armature resistance [ohm].

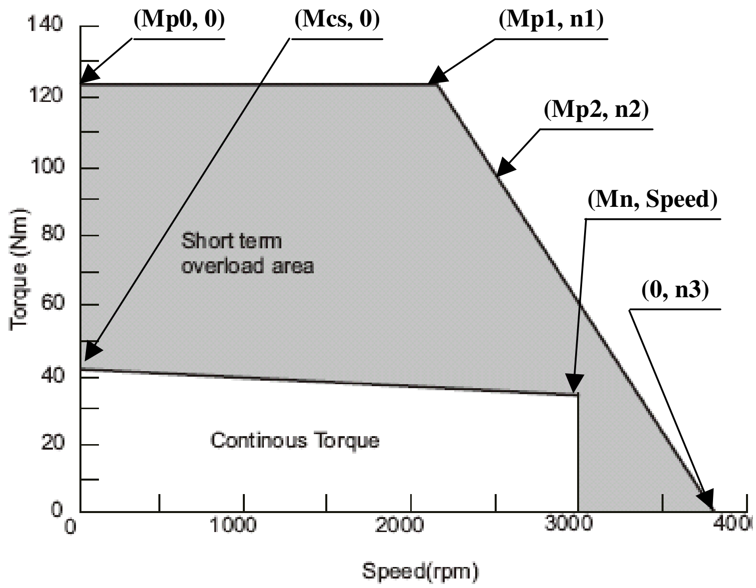


Figure 12. The definition of loadability curve

You can see the input fields for existing motor specifications for ExistingInductionMotor in Table 11.

Table 11. Existing motors specifications for Existing Induction Motor.

Specification	**Options**
Type designation	Any text or string
Voltage [V]	400
Frequency [Hz]	50
Power [kW]	1
Poles	2, 4, 6, 8, 10, 12, 14, 16, 18, 20
Speed [rpm]	1000
Efficiency [%]	90
Power factor	0.8
Tmax/Tn	3
Temp. rise class	B[<80K], F[<105K]
Inertia [Kgm^2]	0.001
IC class	IC411, IC416

5.5.3 Importing own motor list

You can perform dimensioning with motors from your own motor list. Options are Import user motors and Import user induction motors. For User motors, refer to the DriveSize manual.

5.6 Gearing input data

To enter gearings data, open the **Gearing** display (see Figure 13) by clicking the **Gearing** icon in the **System configuration** tree. You can set a maximum of three gears. Each has its own view and data input field.

This software does not include an automatic gear ratio optimization. Set the gear ratio so that the maximum speed is as close to the maximum speed of motor as possible.

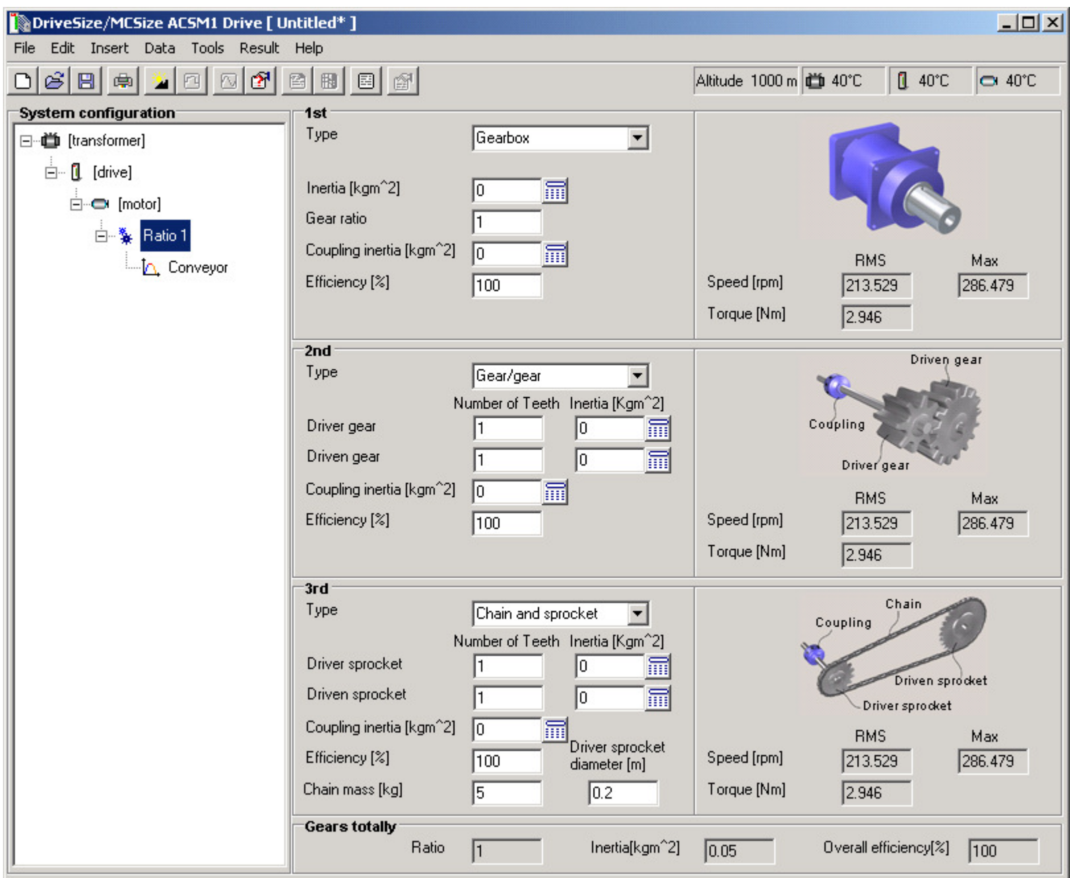


Figure 13. Gearings input data display

The visible gearing settings are determined according to the selected gearing type. Select the desired gearing type from the **Type** drop down list (see Figure 14). The order of gearings from the motor to the load is: Motor - 1st - 2nd - 3rd - Load.

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The available gearing type options are:

- None

- Gear/gear
- Gearbox
- Chain and sprocket
- Belt and pulley

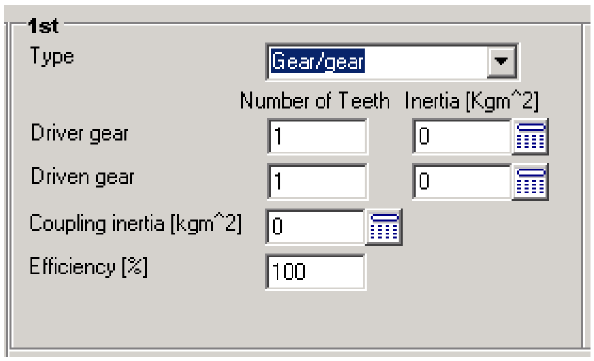


Figure 14. Gearing data input field

5.6.1 Belt and pulley

In belt and pulley gearings the power is transmitted from one pulley to another via a belt (see Figure 15). The ratio of gearing depends on the diameters of the pulleys.

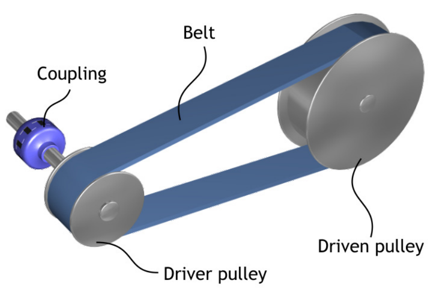


Figure 15. Belt and pulley

You can enter the driver pulley inertia, driven pulley inertia and coupling inertia directly, or you can use the inertia and mass calculator (see chapter 5.1.3. Inertia and mass calculator).

You can see the input fields for the belt and pulley gearing in Table 12.

Table 12. Belt and pulley gearing settings

Setting	Explanation
Driver pulley, Diameter [m]	Enter the exact actual diameter of the driver pulley for the correct calculation of reflected inertia.
Driver pulley, Inertia [kgm^2]	Enter the value of the driver pulley inertia or use the inertia and mass calculator.
Driven pulley, Diameter [m]	Enter the driven pulley diameter. The speed of driven pulley rotation depends on the belt velocity and the diameter of the pulley. Therefore, the exact value of the driven pulley diameter is required for the correct calculation of the reflected inertia value.
Driven pulley, Inertia [kgm^2]	Enter the value of the driven pulley inertia or use the inertia and mass calculator.
Belt mass [kg]	Enter the belt mass. It has an effect on the value of total inertia.
Coupling inertia [kgm^2]	Enter the inertia of coupling at the motor side of the gearing or use the inertia and mass calculator. This value should also include all additional coupling inertia that is not included in the driver pulley inertia value, for example, the additional inertia caused by the shaft.
Efficiency [%]	With the efficiency setting you can take into account the losses of torque. In MCSize the losses are assumed to happen between the belt and driven pulley.

5.6.2 Chain and sprocket

In chain and sprocket gearings the ratio of gearing is inversely proportional to the speeds of the sprockets, that is, to the number of teeth on the sprockets (see Figure 16).

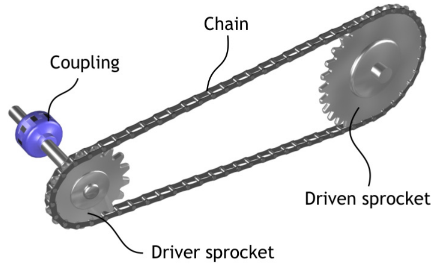


Figure 16. Chain and sprocket

You can enter the driver sprocket, driven sprocket inertia and coupling inertia directly, or you can use the inertia and mass calculator (see chapter 5.1.3. Inertia and mass calculator).

You can see the input fields for chain and sprocket gearing in Table 13.

Table 13. Chain and sprocket gearing

Setting	Explanation
Driver sprocket, Number of teeth	Enter the number of teeth on the Driver sprocket. This value along with the **Driven sprocket, Number of teeth** value generates the gear ratio. The ratio is smaller when reducing the value. MCSize accepts also the value 1.
Driver sprocket, Inertia [kgm^2]	Enter the driver sprocket inertia value or use the inertia and mass calculator to define the inertia value.
Driven sprocket, Number of teeth	The number of teeth on the Driven Sprocket. This value along with the **Driver sprocket, Number of teeth** value generates the gear ratio.
Driven sprocket, Inertia [kgm^2]	Enter the driven sprocket inertia value or use the inertia and mass calculator to define the inertia value. If you want to use the inertia and mass calculator, you must know the gear diameter.
Coupling inertia [kgm^2]	Enter here the inertia of coupling at the motor side of that gearing. This value should also include all additional coupling inertia that is not included in the driver pulley inertia value, for example, the additional inertia caused by the shaft.

Efficiency [%]	With the efficiency setting you can take into account the losses of torque. In MCSize the losses are assumed to happen between the chain and driven sprocket.
Chain mass [Kg]	Enter chain mass information. It affects the value of total inertia.
Driver sprocket diameter [m]	Enter the true diameter of the driver sprocket in order to define the chain's effect on the reflected inertia value.

5.6.3 Gear/gear

The gear ratio of gear construction is inversely proportional to the gear speeds, that is, to the number of teeth on the gears (see Figure 17). The correct gear ratio is required in the calculation of reflected inertia. You can enter the driver and driven inertia directly or use the inertia and mass calculator.

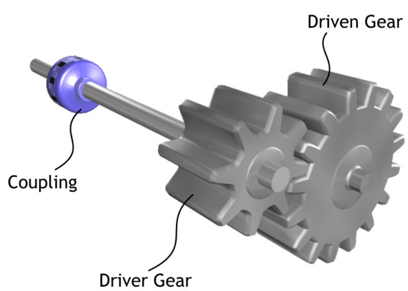


Figure 17. Gear/gear

You can see the input fields for gear/gear gearing in Table 14.

Table 14. Gear/gear gearing settings

Setting	**Explanation**
Driver gear, Number of teeth	Enter here the number of teeth on the Driver gear. This value along with the **Driven gear, Number of teeth** value generates the transformation ratio. MCSize accepts also the value 1.
Driver gear, Inertia [kgm^2]	Enter the driver gear inertia value or use the inertia and mass calculator to define the inertia value. If you want to use the

	inertia and mass calculator to define the inertia value, you must also know the driver gear diameter.
Driven gear, Number of teeth	The number of teeth on the Driven gear. This value along with the **Driver gear, Number of teeth** value generates the transformation ratio.
Driven gear, Inertia [kgm^2]	Enter the driven gear inertia value or use the inertia and mass calculator to define the inertia value. If you want to use the inertia and mass calculator to define the inertia value, you must also know the gear diameter.
Coupling inertia [kgm^2]	Enter the inertia of coupling on the power input side of the gearing or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the driver pulley inertia value, for example, the additional inertia caused by the shaft.
Efficiency [%]	Enter the efficiency. With the efficiency setting you can take into account the loss of torque. In MCSize the losses are assumed to happen in the teeth of gears.

5.6.4 Gearbox

The gearbox is an enclosed gearing, that is, a planetary gear for the gearing of higher rotation speed (see Figure 18). The purpose of a gearbox is to achieve output with high torque and low speed. The gearbox is often integrated into the motor.

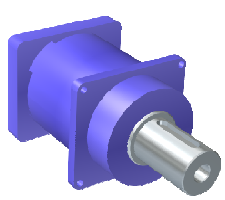


Figure 18. Gearbox

You can see the input fields for gearbox gearing in Table 15.

Table 15. Gearbox gearing input fields

Setting	Explanation
Inertia [kgm^2]	Enter the inertia of the gearbox or use the inertia and mass calculator to define the inertia value. Typically, gearbox manufacturers specify only one value of inertia. This inertia is valid at the power input of gearbox
Gear Ratio	Enter the gear ratio. This value defines how the speed of the input shaft is transmitted to the output shaft of the gearbox. For example, 3 means that three rotations of the input shaft are required for one complete turn of the output shaft.
Coupling inertia [kgm2]	Enter the coupling inertia at the power input side of gearing or use the inertia and mass calculator to define the inertia value.
Efficiency [%]	With the efficiency setting you can take into account the losses of torque. In MCSize the losses are assume to happen in the teeth of gears.

5.7 Motion profile and mechanics

5.7.1 Entering motion profile data

To open the **Motion** display, click the **Motion profile and mechanics** icon (see Figure 19). Enter motion profile information to the data input fields. When you enter a new input value, the program calculates a new motion profile. The results are displayed in the **Motion results** display. The layout of the **Motion results** field changes according to the selected mechanics type, whether linear or rotational. You can also select an optional unit for distance. Click **Change type** to open a drop-down list with options for the type of mechanics.

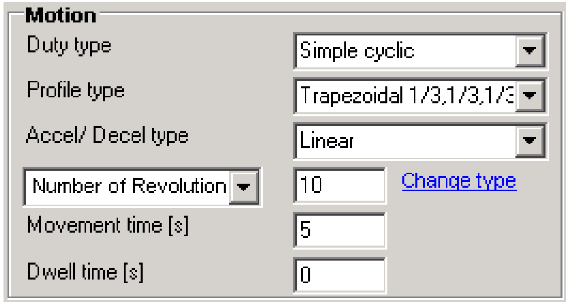


Figure 19. Motion input data

You can see the input fields of **Motion** display in Table 16.

Table 16. Motion input fields

Setting	Explanation
Duty type	Select the duty type. The **Simple cyclic** duty type consists of just one profile that includes the acceleration, continuous speed and deceleration segments. If the **Multiform cyclic** duty type is selected, you can create more complicated cycles, for example, enter several acceleration and deceleration segments. Enter the data in the separate **Motion profiles** display (see Figure 20). With several accelerations, it is possible to accelerate or decelerate from one nonzero speed to another nonzero speed. A motion profile can contain a maximum of 50 segments, including acceleration, deceleration, constant speed, dwell and hold segments. Only simple cyclic is available for Winder and Unwinder mechanics.
Profile type	Select the profile type. The available profile type options are the following: Trapezoidal 1/3, 1/3, 1/3 Trapezoidal 1/4, 1/2, 1/4 Triangular 1/2, 1/2 User defined Fractional numbers here refer to the relative times of acceleration, continuous velocity and deceleration. Acceleration time and deceleration time become

	editable when the profile type is User defined.
Accel/ Decel type	Select the acceleration/deceleration type. You can increase the smoothness of motion with this option. S-curves are used when it is necessary to limit the acceleration change rate (jerk). These curves are also used in dynamic braking. The available s-curve options are the following: **Linear** **1/4 s curve** **5/8 s curve** **Full s curve** You can achieve the smoothest motion with the **Full s-curve** setting, but it requires higher peak acceleration and deceleration to produce an equivalent profile. This means that when s-curves are used, more torque is required to accelerate or decelerate the system inertias.
Movement distance [m], Top speed [m/s] Rotational angle [deg] Number of revolutions	Enter the total distance traveled during the cycle. Acceleration/deceleration is calculated on the basis of given distance and movement time. When linear load is selected, the options are **Movement distance [m]** and **Top speed [m/s]**. When a rotational movement type is selected, a drop down list with three options, **Rotational angle [deg]**, **Number of revolutions** and **Top speed [rev]**, appears.
Movement time [s]	Enter the total movement time for one cycle. Includes the acceleration, constant speed and deceleration segments but does not include the dwell time.
Dwell time [s]	Enter the waiting time between sequential cycles.

5.7.2 Entering more complex profile

To enter the more complicated duty type, select **Multiform cyclic** from the motion input data view (see Figure 19). Select a suitable segment type from the drop-down

list for each segment. Enter the data for different segment types in the input fields and the software calculates the rest (see Table 17). MCSize will display an error message in the motion profile view when entered inputs are incomplete for example, if the final speed of the previous segment does not fit with the new segment. A new row appears automatically after you have entered acceptable inputs for the segment. Click the right mouse button to delete or to insert a new segment between two segments. Select the segment you want to delete or a segment after which you want to insert a new segment. The profile is shown also in graphical form. Graph type options **Speed vs. time** and **Displacement vs. time** are available for graphics.

There is also a possibility to graphically reshape the profile by mouse. Select **Edit** from Graph options**,** use mouse and point out the segment you want to divide into two parts. Click right mouse button and select **Add point**, click left mouse button and a new point appear. Similarly use **Delete line** command to remove segments. Select **Drag** from Graph Options**,** use mouse and left mouse button to move the red dots.

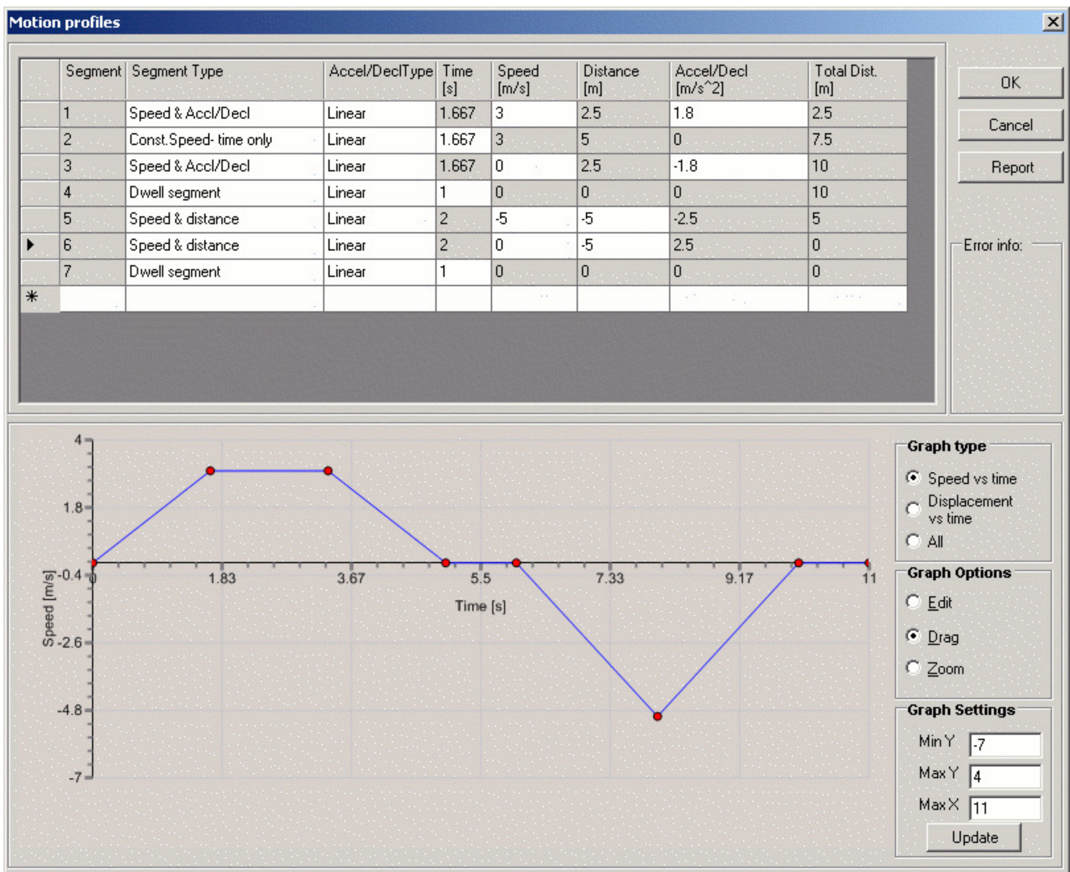


Figure 20. Motion profiles display

Use Graph Settings to change the scale of graph. Enter the new values of axis and click **Update** push button.

The zoom function is available when the total cycle time exceeds ten seconds or the number of segments is ten or more. Select **Enable Zoom**, use mouse and left mouse button to highlight a period you want to zoom in.

Click the  push button to zoom out.

You can see the input fields of **Multiform cyclic** display in Table 18.

Table 17. Segment types

Point type	**Explanation**
Speed & Accl/Decl	For the acceleration or deceleration segment. Enter the final velocity in the end of this segment and the desired value of acceleration. Negative acceleration means deceleration when the speed is positive and vice versa.
Speed & Time	For the acceleration or deceleration segment. Enter the duration or accelerating/decelerating segment and the final speed in the end of this segment. The initial speed and the end speed must have the same sign (both negative or both positive). Reversal is possible via zero speed point only.
Speed & Distance	For the acceleration or deceleration segment. Enter the final velocity at the end of this segment and the desired distance to be travelled during this segment. The distance and the speed must have the same direction (both negative or both positive)
Accl/Decl & Distance	Segment type for acceleration or deceleration segment. Enter the desired acceleration and the distance for the segment. Negative value means deceleration when the speed is positive and vice versa.
Accl/Decl & Time	Segment type for the acceleration or deceleration segment. Enter the desired acceleration and the duration of acceleration for the segment. Negative acceleration means deceleration when

	the speed is positive and vice versa.
Distance & Time	For the acceleration or deceleration segment. Enter the duration of this segment and the desired distance to travel during the segment. Negative distance means that the direction of movement is negative.
Dwell segment	This is zero speed and no-load waiting segment between motion segments. The final speed of the previous segment must be zero. Enter the duration of dwell segment
Const. speed – distance only	For the constant speed segment. Enter the distance traveled during this segment. Speed is the final speed of previous segment. The previous segment determines the direction of movement.
Const. speed – time only	For the continuous speed segment. Enter the duration of constant speed segment. Speed is the final speed of the previous segment. The previous segment determines the direction of movement.
Hold segment	This is zero speed hold segment between motion segments. Hold torque is determined by mechanics. Enter the duration of hold segment. The end speed of the previous segment must be zero.

Table 18. Motion profile inputs for Multiform cyclic load type

Setting	**Explanation**
Segment	Sequence number. You can enter 2…50 segments.
Segment Type	Speed & Accl/Decl, Speed & Time, Speed & Distance, Accl/Decl & Distance, Accl/Decl & Time, Distance & Time, Dwell segment, Const. speed – distance only, Const. speed – time only, Hold segment.
Accel/DeclType	Select the acceleration/deceleration type. You can increase the smoothness of motion with this option. S-curves are used when it is necessary to limit the

	acceleration change rate (jerk). The available s-curve options are the following: **Linear** **1/4 s curve** **5/8 s curve** **Full s curve** You can achieve the smoothest motion with the **Full s-curve** setting, but it requires higher peak acceleration and deceleration to produce an equivalent profile. This means that when s-curves are used, more torque is required to accelerate or decelerate the system inertias.
Time [s]	The duration of the segment.
Speed [m/s], [rad/s]	The end speed for acceleration or deceleration segment.
Distance [m], [rad]	Angular distance traveled during the duration of the segment.
Accel/Decl [m/s^2], [rad/s^2]	The mean value of acceleration for the segment. A positive sign means acceleration to the positive direction and vice versa. A negative sign means deceleration when the direction of the movement is positive and vice versa.
Total Dist. [m], [rad]	Total distance or angular distance from the start position to the end position.

5.7.3 Entering mechanics data

You can select the type of the mechanical application from the **Type** drop-down list in the **Mechanics** display (see Figure 21).

The available mechanics types are the following:

- Conveyor, which is also the default
- Cylinder
- Feed roll
- Lead screw
- Rack & pinion

- Rotating table
- User defined
- Winder
- Unwinder

Each item has its own view and input fields. **User defined** and **Cylinder** are more universal mechanics types for linear and rotational movements respectively.

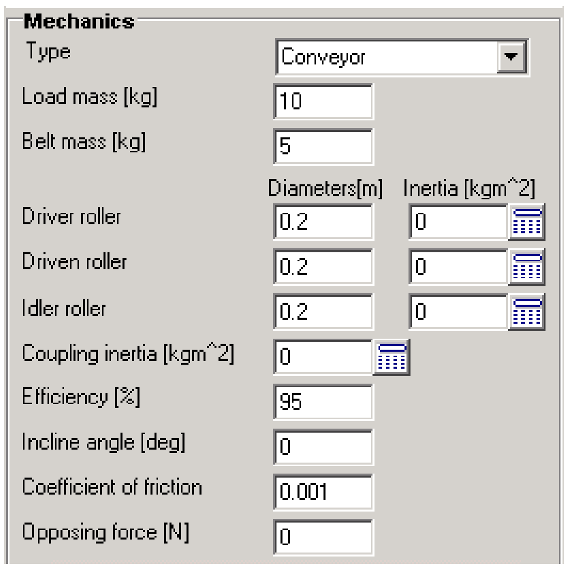


Figure 21. Mechanics input data

You can use the inertia and mass calculator to calculate the inertia of mechanical parts on the basis of their dimensions, weight and material. To open the inertia and mass calculator, click the calculator button next to an inertia input field.

5.7.3.1 Conveyor

Industrial conveyors are material handling machinery that are used for moving bulk materials from one place to another at a controlled rate (see Figure 22). A belt conveyor consists of an endless loop belt and a roller system in which idler rollers are often used to support the belt. The belt position can be horizontal, inclined or declined. The direction of movement is mostly forward but reverse is also possible.

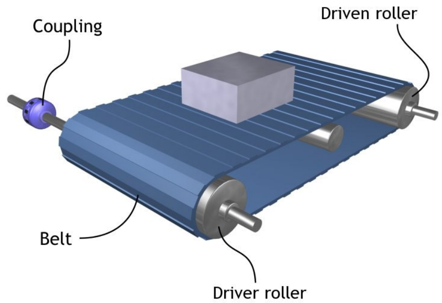


Figure 22. Conveyor mechanics

You can see the input fields for conveyor mechanics in Table 19.

Table 19. Conveyor mechanics settings

Setting	**Explanation**
Load Mass [kg]	Enter the total mass of the load to be conveyed.
Belt Mass [kg]	Enter the belt mass. It affects the value of total inertia and the frictional forces.
Driver roller, Diameter [m]	Enter the exact driver roller diameter for the correct calculation of driven roller inertia, load inertia, belt inertia and idle roller inertia.
Driver roller, Inertia [kgm^2]	Enter the value of driver roller inertia or use the inertia and mass calculator to define the inertia value.
Driven roller, Diameter [m]	Enter the driven roller diameter for the calculation of the effect of the inertia of these rollers on the system inertia.
Driven roller, Inertia [kgm^2]	Enter the driven roller inertia or use the inertia and mass calculator to define the inertia value. The rotation speed of the driven roller depends on the belt velocity and the diameter of the driven roller. For correct inertia value calculations, enter the exact diameter of the driven roller.
Idler roller, Diameter [m]	Enter the idler roller diameter for the calculation of the effect of the inertia of these rollers to the system inertia.

Idler roller, Inertia [kgm^2]	Enter the total inertia for all the idler rollers (typically there are several idler rollers to support the belt) or use the inertia and mass calculator to define the inertia value. Notice that you must enter the exact diameter of the idler rollers for the correct calculation of system inertia. Use zero value when there are no rotating idler rollers in the conveyor.
Coupling Inertia [kgm^2]	Enter the inertia of the coupling between the gearings and the conveyor or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the driver pulley inertia value, for example, the additional inertia caused by the shaft.
Efficiency [%]	Enter the efficiency percentage of the conveyor mechanics. You can take into account power losses with efficiency. The efficiency value defines how much more torque is needed due to the losses.
Incline Angle [deg]	Enter the incline angle between the belt and the horizontal plane. Only a positive value of the incline angle is possible. Positive distance means upward motion and negative distance means downward motion.
Coefficient of friction	Enter the coefficient of friction. It takes into account all the frictional losses of the conveyor system due to the load and belt. It includes the friction between the guides and the belt, the belt and the rollers as well as the bearing friction of the rollers. It is assumed that frictional losses are independent when the angle is inclined.
Opposing force [N]	Enter the sum of forces acting against the belt movement, for example, thrust load trying to push the load off from the belt.

5.7.3.2 Cylinder

In MCSize the cylinder drive is the universal load type for rotational movement (see Figure 23). For example, a load can consist of several cylinders with different diameters that are attached to a common shaft.

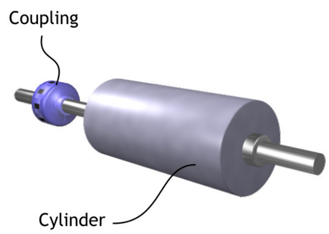


Figure 23. Cylinder drive mechanics

You can see the input fields for cylinder drive mechanics in Table 20.

Table 20. Cylinder mechanics settings

Setting	**Explanation**
Load inertia [kgm^2]	Enter the total inertia of the cylinder or use the inertia and mass calculator to define the inertia value.
Coupling inertia [kgm^2]	Enter the inertia of the coupling between the gearing and the cylinder drive mechanics or use the inertia and mass calculator to define the inertia value. This value should also include all additional inertia that is not included in the load inertia value, for example, the additional inertia caused by the shaft.
Efficiency [%]	Enter the efficiency percentage (the percentage of the input torque provided to output). The losses of the cylinder drive mechanics are taken into account in the efficiency.
Conversion diameter [m]	Enter the diameter for thrust force. The thrust load diameter is the doubled distance between the center of the cylinder shaft and the impact point of the opposing force.

Opposing force [N]	Enter the total sum of opposing forces in this input field. The opposing forces include, for example, the thrust load acting against the movement at a certain radius on the load.

5.7.3.3 Feedroll

You can see the example of feedroll mechanism in the Figure 24.

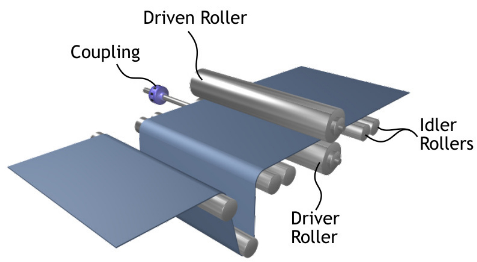


Figure 24. Feedroll mechanics

You can see the input fields for feed roll mechanics in Table 21.

Table 21. Feed roll mechanics settings

Setting	**Explanation**
Load mass [kg]	Enter the total load of the material to be moved.
Number of rolls, Driver roller	Enter the number of driver rolls in the feedroll.
Number of rolls, Pinch	Enter the number of rolls in the pinch.
Inertia, Driver roller	Enter the driver roller inertia or use the inertia and mass calculator to define the inertia value.
Inertia, Pinch	Enter the pinch inertia or use the inertia and mass calculator to define the inertia value. The rotation speed of the pinch feed roll depends on the strip velocity and the diameter of the roller.
Diameter, Driver roller	Enter the exact diameter of the driver roller for correct load inertia and tensional torque calculations.

Diameter, Pinch	Enter the exact diameter of the pinch for correct system inertia calculations.
Coupling inertia [kgm^2]	Enter the inertia of the coupling between the gearing and the feed roll mechanics or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the driver roller inertia value, for example, the additional inertia caused by the shaft.
Efficiency [%]	Enter losses that should be taken into account in the torque efficiency. This data defines how much more torque is needed because of the losses.
Strip tension [N]	Enter the tensional force or pull through force that is needed to achieve the desired material tension on the input side of the roller system.
Frictional force [N]	Enter the tensional force that is needed to pinch the strip material in the roller system.

5.7.3.4 Lead screw

A lead screw consists of a screw with a nut moving along it (see Figure 25). The rotational motion of the screw turns to the linear motion of the nut. The high torque and low speed of the linear motion can be achieved depending on the value of the screw pitch. The screw position can be horizontal, vertical, inclined or declined. Use counterbalance to eliminate the gravitation component caused by the incline angle, if necessary.

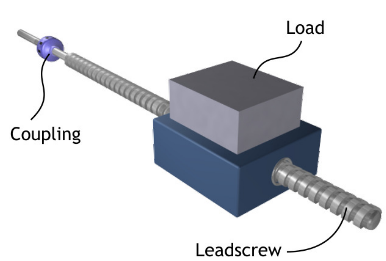


Figure 25. Lead screw mechanics

You can see the input fields for lead screw mechanics in Table 22.

Table 22. Lead screw mechanics settings

Setting	**Explanation**
Load mass [kg]	Enter the total load mass to be transported.
Table mass [kg]	Enter the mass of the table. It has an effect on the value of total inertia and on the frictional forces. All the linearly moving parts (for example, the nut) are taken into account here.
Counter balance mass [kg]	If counterbalance is used, enter its mass. Note that the acceleration of free fall, or 9.82 m/s^2, is the natural maximum limit for acceleration when counterbalance is used. If no counterbalance is used, enter zero value to this input field.
Lead screw Inertia [kgm^2]	Enter the screw inertia or use the inertia and mass calculator to define the inertia.
Coupling inertia [kgm^2]	Enter the inertia of the coupling between the gearings and the conveyor or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the screw inertia value, for example, the additional inertia caused by shafts.
Efficiency [%]	Enter the efficiency percentage of lead screw mechanics. The losses of lead screw mechanics, for example, the loss of power due to friction in the bearings, is taken into account with efficiency. The value indicates how much more torque is needed due to the losses.
Incline angle [deg]	Enter the incline angle between the screw and the horizontal plane. Only a positive value of the incline angle is possible. Positive distance means upward motion and negative distance means downward motion.
Coefficient of friction	Enter the coefficient of friction. It takes into account the frictional losses between the table and the support or the guide

	bar. These losses are caused by the total weight of the load and the table. This opposing component is dependent on the cosine of incline angle.
Opposing force [N]	Enter the sum of all opposing forces that affect the movement of the table, for example, the thrust load or the preload force. Preload is the opposing force that must be overcome before the load starts to move.
Lead screw pitch [mm]	Enter the linear distance the nut advances for one complete turn of the screw.

5.7.3.5 Rack & pinion

The rack & pinion mechanics consist of pinion and rack gears that transfer the rotational motion of the pinion to the linear movement of the rack (see Figure 26). The rack position can be horizontal, vertical, inclined or declined.

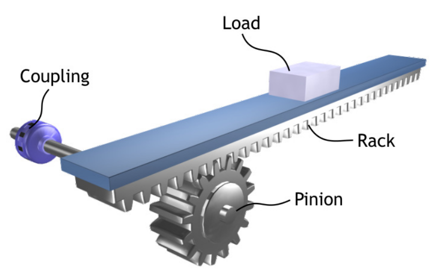


Figure 26. Rack and pinion mechanics

You can see the input fields for rack and pinion mechanics in Table 23.

Table 23. Rack and pinion mechanics settings

Setting	**Explanation**
Load mass [kg]	Enter the total load mass to be transferred.
Rack mass [kg]	Enter the mass of the rack including the mass of all parts that move linearly.
Pinion diameter [m]	Enter the exact pitch circle diameter of the pinion for the correct calculation of

	load inertia, rack inertia, etc.
Pinion inertia [kgm^2]	Enter the inertia of the pinion or use the inertia and mass calculator to define the inertia value.
Coupling Inertia [kgm^2]	Enter the inertia of coupling between gearings and pinion or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the pinion inertia value, for example, the additional inertia caused by shafts.
Efficiency [%]	Enter the losses of rack & pinion mechanics. For example, the frictional loss of bearings is taken into account in the efficiency coefficient. The efficient defines how much more torque is needed due to the losses.
Incline angle [deg]	Enter the incline angle. It is the angle between the rack and the horizontal plane. Only a positive value of the incline angle is possible. Positive distance means upward motion and negative distance means downward motion.
Coefficient of friction	Enter the coefficient of friction. It takes into account the frictional losses between the rack and the support. These losses are caused by the total weight of the load and the rack. This opposing component depends also on the cosine of the incline angle.
Opposing force [N]	Enter the thrust load, that is, the sum of forces that effects against the movement of the rack.

5.7.3.6 Rotating table

A horizontally rotating table is controlled through a shaft and a coupling (see Figure 27). The table moves and positions bulk loads.

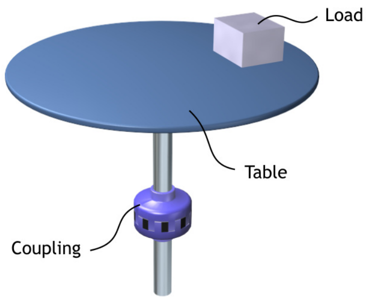


Figure 27. Rotating table mechanics

You can see the input fields for rotating table mechanics in Table 24.

Table 24. Rotating table mechanics settings

Setting	**Explanation**
Load mass [kg]	Enter the total load mass to be moved.
Load - center distance [m]	Enter the distance between the center of the table and the center of the weight. The radius can be defined as the average of the inside radius and outside radius. The inertia of the load depends on its position in relation to the center of the table.
Table inertia [kgm^2]	Enter the inertia of the table and the shaft or use the inertia and mass calculator to define the table and shaft inertia value.
Coupling inertia [kgm^2]	Enter the inertia of the coupling between the gearings and the rotary table or use the inertia and mass calculator to define the inertia value. This value should also include all additional coupling inertia that is not included in the table inertia value, for example, the additional inertia caused by shafts.
Efficiency [%]	Enter the efficiency percentage of input power provided to output. The efficiency value takes into account the losses of the rotating table mechanics.
Opposing force distance [m]	Enter the opposing force distance. It is equivalent to the distance from the center of the table to the impact point of

	opposing frictional force.
Opposing force [N]	Enter the opposing force. The opposing force can be any additional frictional force that acts on a certain area from the center of the table.

5.7.3.7 User defined

User defined is the universal load type for linear movement in this software. The inertia of linear load is converted to rotational movement with the conversion diameter defined by the user. See the general structure of user defined mechanics in Figure 28.

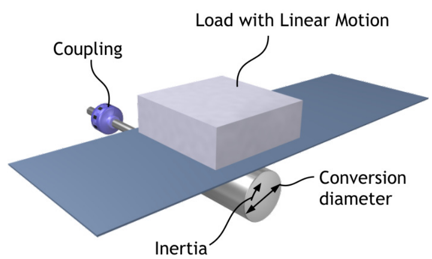


Figure 28. User defined mechanics

You can see the input fields for user defined mechanics in Table 25.

Table 25. User defined mechanics settings

Setting	**Explanation**
Load mass [kg]	Enter the total load mass to be conveyed.
Conversion diameter [m]	Enter the conversion diameter. The diameter defines the distance the load travels for the full revolution of the input shaft. The distance is equal to π multiplied by the conversion diameter.
Coupling inertia [kgm^2]	Enter the inertia of coupling between the gearing and the user defined mechanics or use the inertia and mass calculator to define the inertia value. You can add any load side rotating inertia to this input field.
Efficiency [%]	Enter the losses of user defined mechanics. For example, frictional losses are taken into account in the efficiency.

	The system's efficiency is defined as the percentage of the input torque provided to output.
Coefficient of friction	Enter the coefficient of friction. It takes into account the frictional losses caused by the weight of load.
Opposing force [N]	Enter the sum of any opposing forces that affect the movement of linear load, for example, thrust load.

5.7.3.8 Winder

A centerwind type of mechanics winds material around a core or a reeling drum (see Figure 29). In this type of winder the center of coil is driven by motor. In the figure the positive direction of angular speed and tension are shown. The MCSize assumes that winding starts from minimum diameter to maximum without stops. Due to this the Multiform cyclic Duty type is not valid.

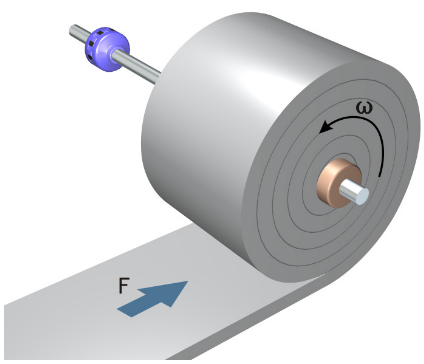


Figure 29. Winder mechanics.

You can see the input fields for winder mechanics in Table 26.

Table 26. Winder mechanics settings

Setting	**Explanation**
Max diameter [m]	Diameter of the complete coil.
Min diameter [m]	This is the initial value of diameter when rewinding starts. In many cases this is the diameter of core or reeling drum.
Coupling inertia [kgm^2]	Enter the inertia of coupling between the

	gearing and the winder mechanics or use the inertia and mass calculator to define the inertia value. You can add any load side rotating inertia to this input field.
Core inertia [kgm^2]	Enter the total inertia of core and shaft or use the inertia and mass calculator to define the inertia value. This is the initial value of inertia.
Efficiency [%]	Enter the efficiency percentage of input torque provided to output. The efficiency value takes into account the losses of the winder mechanics like bearings.
Width [m]	Enter the width of material.
Density [kg/m^3]	Enter material density information. It affects the value of inertia.
Tension [N]	Enter the tensional force that is needed to achieve the desired material tension.
Opposing force [N]	Enter the sum of any opposing forces that affect the movement of reeled material. This force is acting against movement at the surface of the coil.

5.7.3.9 Unwinder

A centerwind type of mechanics is unwinding material from reel (see Figure 30). In this type of winder the center of coil is driven by motor. When the positive directions are according to the figure the normal running power is negative and will be shown in second quadrant in torque speed diagram. The MCSize assumes that winding starts from maximum diameter to minimum without stops. Due to this the Multiform cyclic Duty type is not valid.

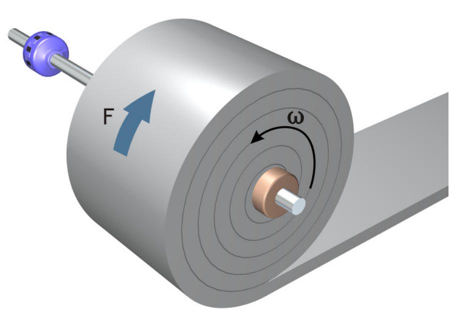


Figure 30. Unwinder mechanics.

You can see the input fields for winder mechanics in Table 27.

Table 27. Unwinder mechanics settings

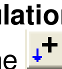
Setting	**Explanation**
Max diameter [m]	Diameter of the full coil. This is the initial value of diameter when unwinding.
Min diameter [m]	This is the final value of diameter when unwinding ends. In many cases this is the diameter of core or reeling drum.
Coupling inertia [kgm^2]	Enter the inertia of coupling between the gearing and the winder mechanics or use the inertia and mass calculator to define the inertia value. You can add any load side rotating inertia to this input field.
Core inertia [kgm^2]	Enter the total inertia of core and shaft or use the inertia and mass calculator to define the inertia value.
Efficiency [%]	Enter the efficiency percentage of input torque provided to output. The efficiency value takes into account the losses of the unwinder mechanics like bearings.
Width [m]	Enter the width of material.
Density [kg/m^3]	Enter material density information. It affects the value of coil inertia.
Tension [N]	Enter the tensional force that is needed to achieve the desired material tension.
Opposing force [N]	Enter the sum of any opposing forces that affect the movement of reeled material. This force is acting against movement at the surface of the coil.

5.7.4 Inertia and mass calculator

When entering inertia data, for example, in the **Motor load**, **Gearing** or **Mechanics** displays, you can use the Inertia and mass calculator v1.1© program developed by ControlEng Corporation for the calculation of inertia (see Figure 31).

Click the calculator button () next to the **Inertia [kgm^2]** value fields to open the inertia and mass calculator.

To calculate the inertia and mass with the inertia and mass calculator:

1. Select the element shape and, in most cases, enter the dimensions of the mechanical component.
2. Enter the material and density. The mass and the inertia are calculated automatically and displayed in the **Mass** and **Inertia** fields.
3. Add the calculated mass and inertia to the **Calculation Table** field for the calculation of total mass and inertia by clicking the  (positive) or  (negative) button at the bottom of the **Inputs** field. To replace an active row from the **Calculation table** with the information in the **Inputs** field, click the  button.
4. Feed another mass and inertia information and add it to the totals, if necessary.

To remove a row from the **Calculation Table**, activate it and click the  button.

To display and modify information in a row in the **Calculation Table** in the **Inputs** field, activate the row and click the  button.

Note that the unit of inertia must be **kg-m^2**.

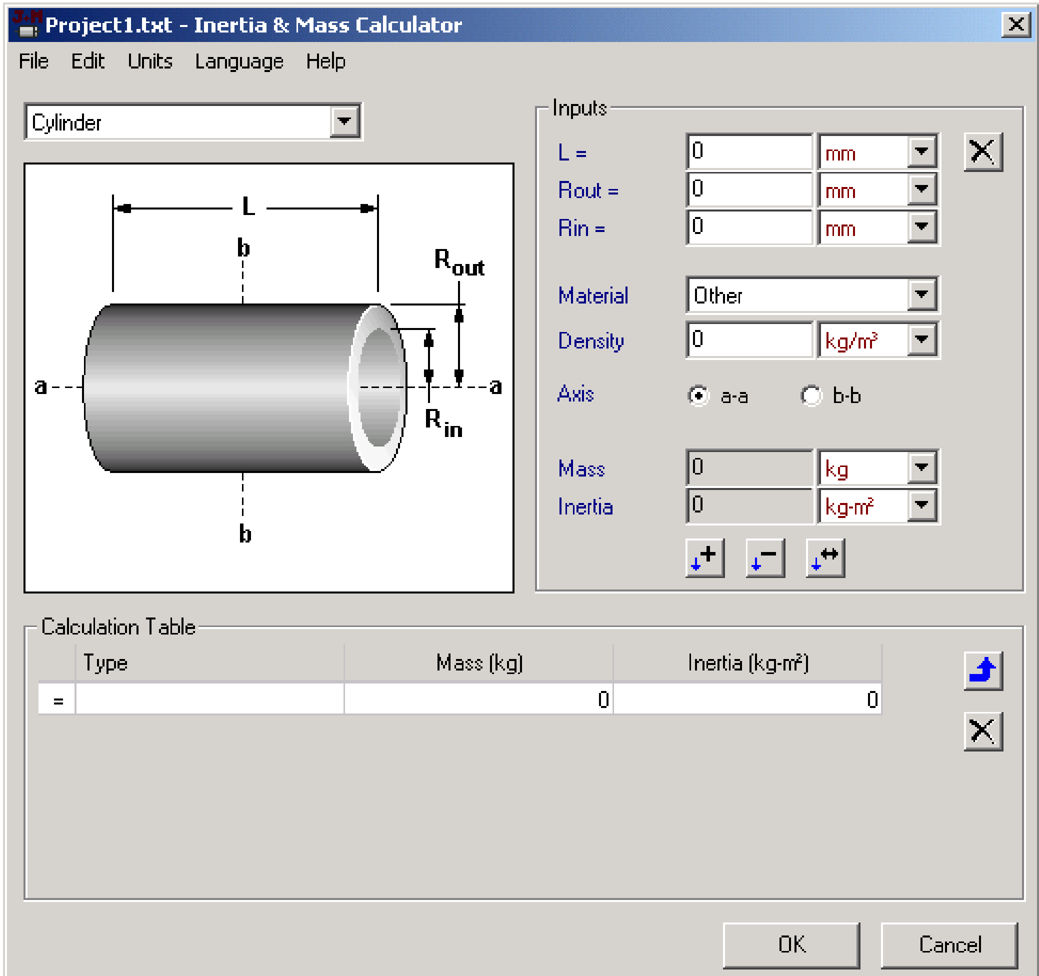


Figure 31. Inertia and mass calculator

5.8 Sizing examples

The software includes example project files that include pre-filled input data. With these files you can learn quickly how the software works and how to enter data.

To open a sizing example file:

Select **File > Examples** and pick the desired file from the list.

5.9 Network check

Use **Network check** for harmonics calculation. Refer to the DriveSize user manual, *Chapter 5 – Network check*.

6 Results

6.1 Motion and mechanics results

To open the **Motion results** display (see Figure 32), click the **Motion** icon in the System configuration tree.

Motion results, mechanical results and combined results are calculated immediately when new data is entered to the Motion and Mechanics input fields.

6.1.1 Motion results

The calculation of motion results is based on the Motion profile input data.

The results are also shown in graphical form. The motion profile graph in the **Motion results** display includes two **Graph type** display options, **Speed vs. time** and **Displacement vs. time**.

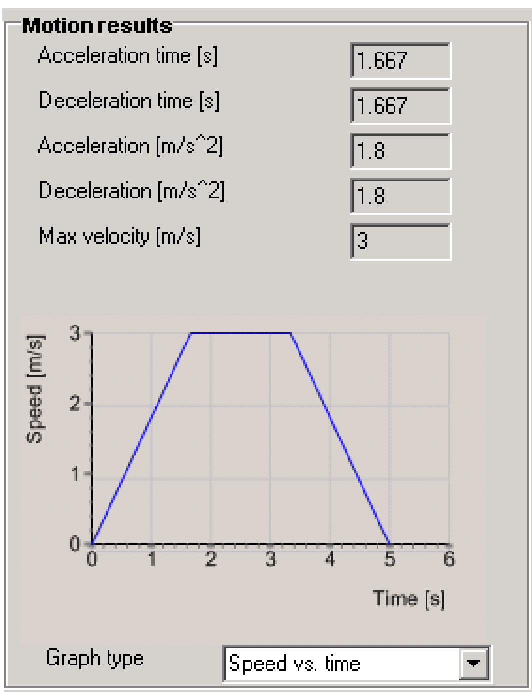


Figure 32. Motion results

You can see the result fields of the Motion results display in Table 28. These values produce the profile that is entered to the input fields of the motion display.

Table 28. Motion results

Result	Explanation
Acceleration time [s]	Calculated acceleration time. This field is editable when the Profile type is **User Defined**.
Deceleration time [s]	Calculated deceleration time. This field is editable when the Profile type is **User Defined**.
Acceleration [m/s^2], [deg/s^2] or [$1/s^2$]	Calculated equivalent value of acceleration. Units are selected automatically depending on whether linear or rotational movement is used.
Deceleration [m/s^2], [deg/s^2] or [$1/s^2$]	Calculated equivalent value of deceleration. Units are selected automatically depending on whether linear or rotational movement is used.
Max velocity [m/s], [deg/s] or [rpm]	Calculated maximum velocity
Velocity at max dyn power [m/s], [rpm] or [deg/s]	When S-curves are applied the movement speed where the maximum power is required is not at maximum speed but lower. Applying s-curves might allow smaller motors than without because the high torque at max speed is avoided.

6.1.2 Mechanical results

The values displayed in the **Mechanical results** field (see Figure 33) are only intermediate results and they are true at the input shaft of mechanics. Gearings are not taken into account here.

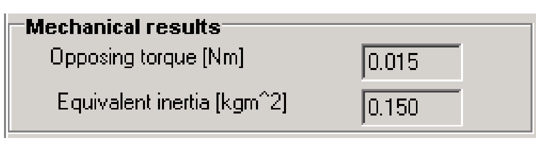


Figure 33. Mechanical results

You can see the items in the Mechanical results field in Table 29.

Table 29. Mechanical results

Result	Explanation

Opposing torque [Nm]	Intermediate opposing torque for mechanics only. Motor and gearings are not taken into account.
Equivalent inertia [Kgm^2]	Intermediate inertia at input shaft for mechanics only. Motor and gearings are not taken into account.

6.1.3 Combined results at driver shaft

The combined results for motor selections are displayed in the **Combined results** field (see Figure 34). These results are true at the input shaft of mechanical application. Gearings are not taken into account.

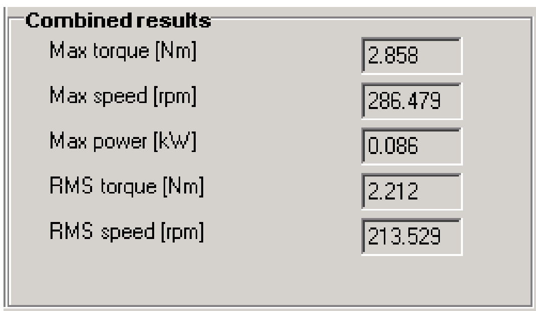


Figure 34. Combined results at the driver shaft

You can see the items in the Combined results field in Table 30.

Table 30. Combined results display items

Item	**Explanation**
Max torque [Nm]	Calculated maximum torque for given profile and mechanics
Max speed [rpm]	Calculated maximum speed for given profile and mechanics
Max power [kW]	Calculated maximum torque for given profile and mechanics
RMS torque [Nm]	Calculated root mean squared torque for given profile and mechanics
RMS speed [rpm]	Calculated root mean squared speed for given profile and mechanics. This is the speed that corresponds with the calculated RMS torque.

Speed at max dyn. power [rpm]	Rotational speed where maximum torque load exists. This appears when s-curves are used. Applying s-curves might allow smaller motors than without because the high torque at max speed is avoided.

6.2 Gearing results

To view gearing results, click on the **Gearing** icon in the System configuration tree. You can see the results of gearings in the **Gearing** display, on the right side of the gearing settings (see Figure 35).

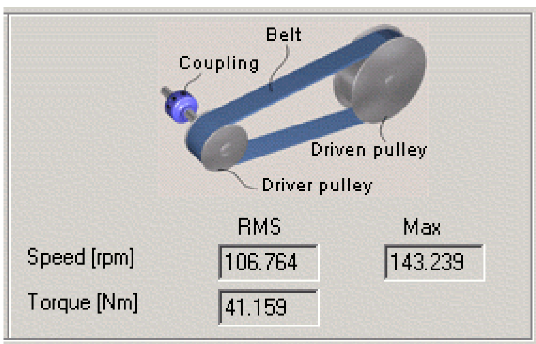


Figure 35. Gearing results

RMS torque and speed are root mean squared results at the input side of gearing. The order of gearings is read from the motor output to the mechanics input, that is, the 1st gearing is connected to the motor shaft, the 2nd shaft is coupled to the output shaft of the 1st gearing, and so on.

At the bottom of the **Gearing** display you can see the total values of all gearings in the **Gears totally** field (see Figure 36).

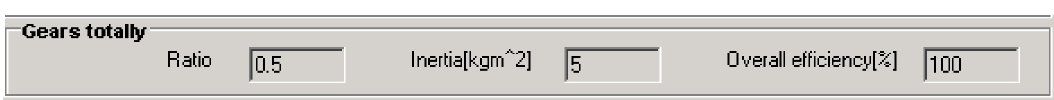


Figure 36. Total values of all gearings

You can see the results in the Gears totally field in Table 31.

Table 31. Gears totally result items

Result	**Explanation**

Total gear ratio	Combined gear ratio for all gears
Inertia due to gears [kgm^2]	Combined inertia of all gears at motor shaft
Overall efficiency [%]	Combined efficiency for all gears

6.3 Results menu

To show dimensioning results first select the drive component or the supply unit from the tree and then click the icon or select **Result > Dimensioning result**.

6.3.1 Graphs

To show Graphs, click the icon or select **Result > Graphs**. This opens the **Graph** window that displays graphs for the following graph options:

- Load/Motor graph
- Inverter
- Performance and profile graph

For inverters the following options are available:

- Current
- DC power

To show supply unit DC power graph, select supply from system configuration tree and click the graph icon.

6.3.2 Multi-graph view

To show several graphs at a time, select the components from the system configuration tree. To highlight several components use the **Ctrl** key, mouse and left mouse button. Press and hold down the **Ctrl** key when selecting components. Select first the object that you want to see uppermost. Two of the graphs are shown at once and you can change the lower one by scrolling the graphs. You can show the multi-graph view for all graph options (see Figure 37).

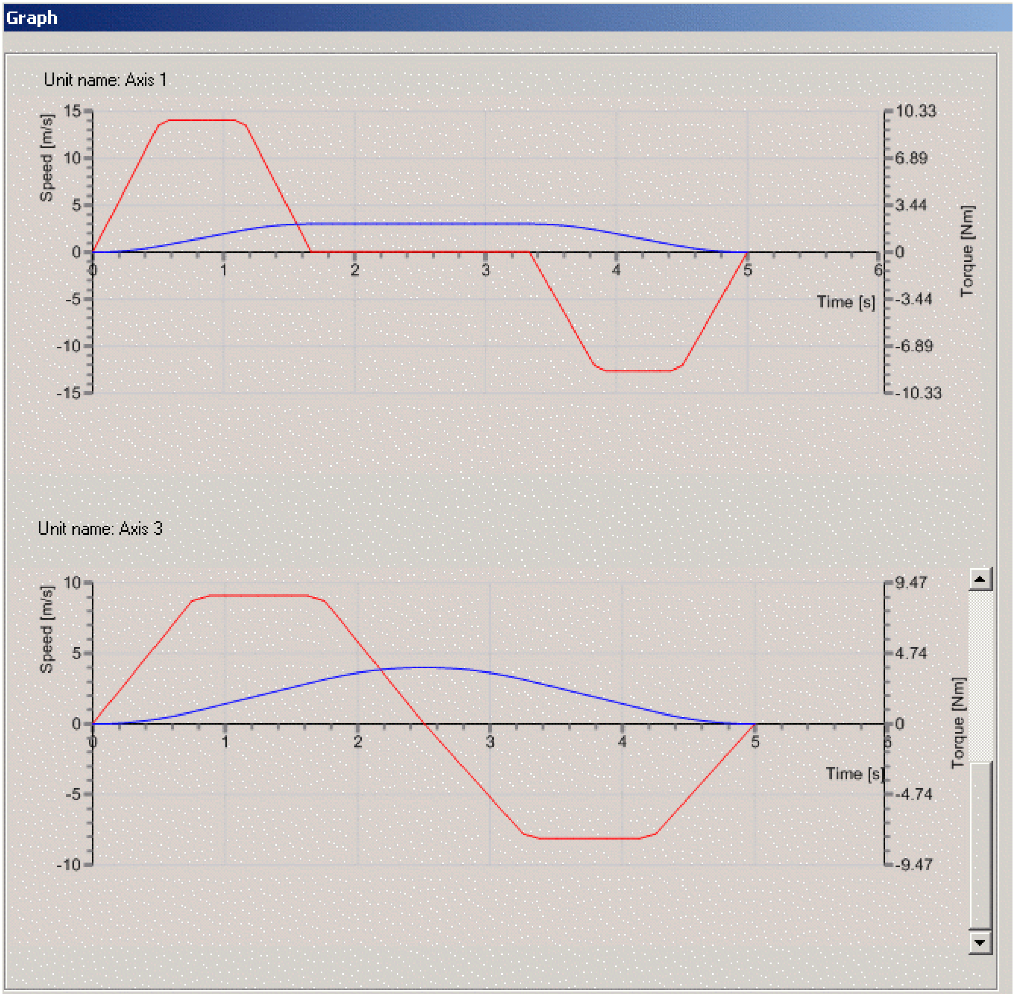


Figure 37. Performance and profile multi-graph view

6.3.3 Reports

To show Reports, select **Result** > **Reports** or click the **Report** button in the result or graph display. To show more project data sheets at once, see chapter 7.

6.4 Motor results

The motor **Selection data** is shown in the **Motor data** field of the **Motor Results** display (see Figure 38). Calculated margins are between the following values:

- Required RMS torque to the nominal torque of motor
- Required peak torque to the maximum short term torque of motor

In the motor data display you can see also Inertia ratio, Max air gap torque, RMS torque, Motor copper losses, Specifications and Catalogue data for the selected motor.

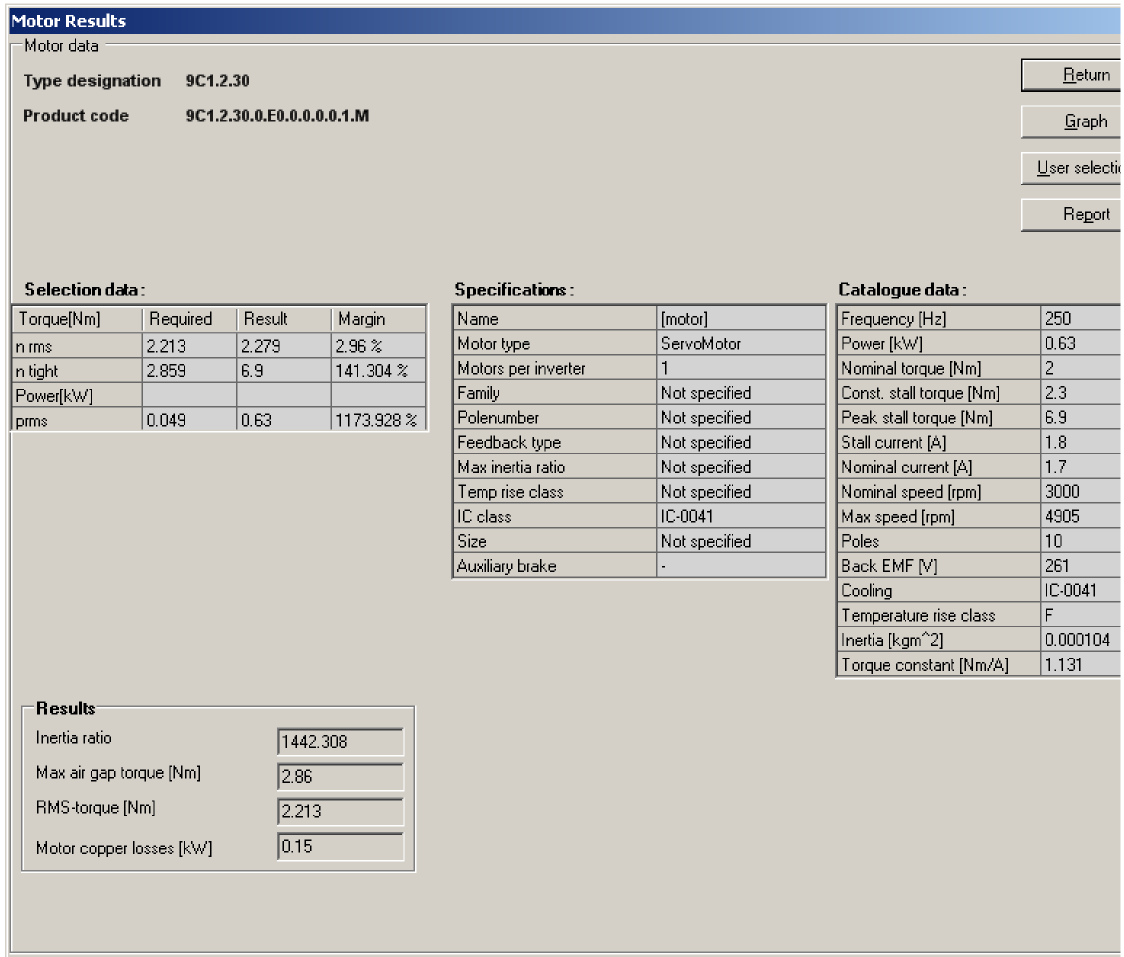


Figure 38. Motor selection data

6.4.1 Motor Graph

You can see the motor results also in graphical form (see Figure 39 and Figure 40). Calculated RMS torque at RMS speed, dynamic torques and limits are illustrated in a motor graph. The green torque (speed curve) defines the thermal long-term limits of the motor. The red curve defines limits for short term intermittent loads and maximum allowed speeds for these loads. These required results are calculated on the basis of the motor air gap torque. The effect of motor inertia is also taken into consideration.

The selection criteria for a motor are:

- Calculated RMS torque must be inside the range of the **Cont loadability** limit.
- Dynamic peak torque curve must be inside the range of the **Max. loadability** limit.

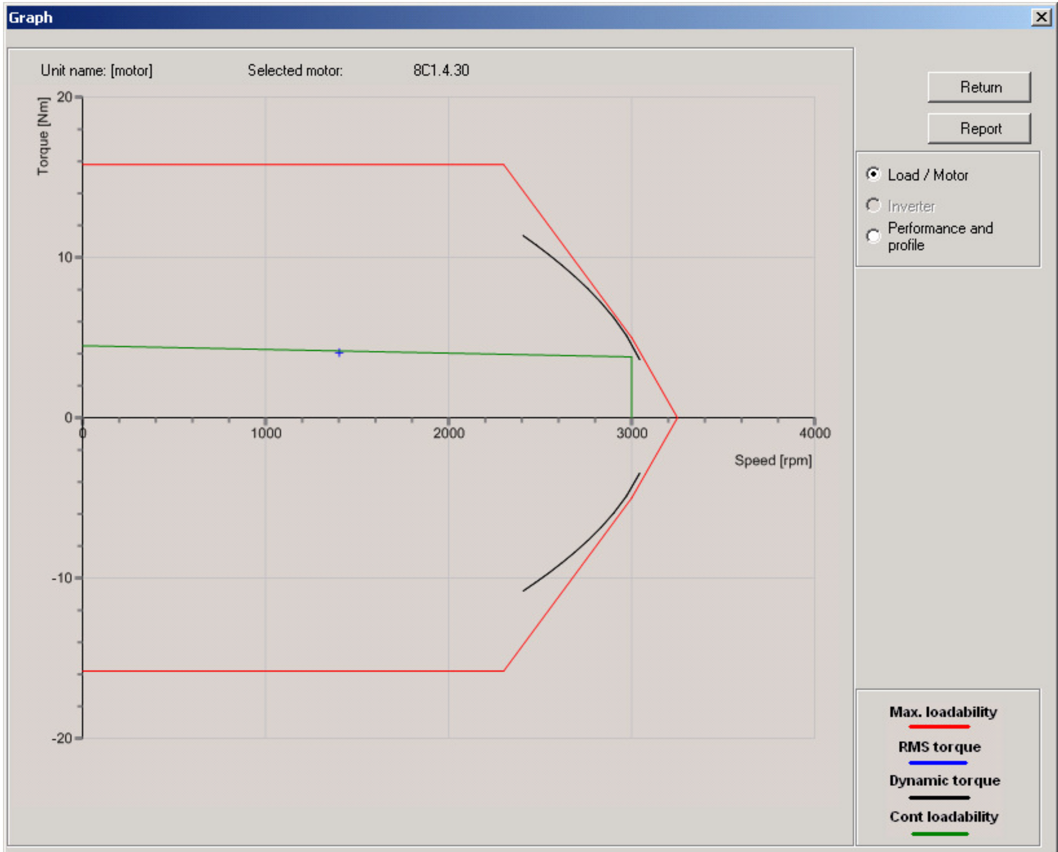


Figure 39. Motor Graph display for ServoMotor

Please notice in this case the dynamic torque curves. They are shown as black arcs and in this close to optimal case they are very close to max torque of motor.

The Motor Graph may have up to four quadrants if the application is braking and running in reverse direction at the same time. The required torque curves are not shown in full length to keep the graph uncluttered. If s-curves are applied the parts of torque curve representing maximum mechanical power are displayed.

Notice that drive's switching frequency has an effect to torque curves.

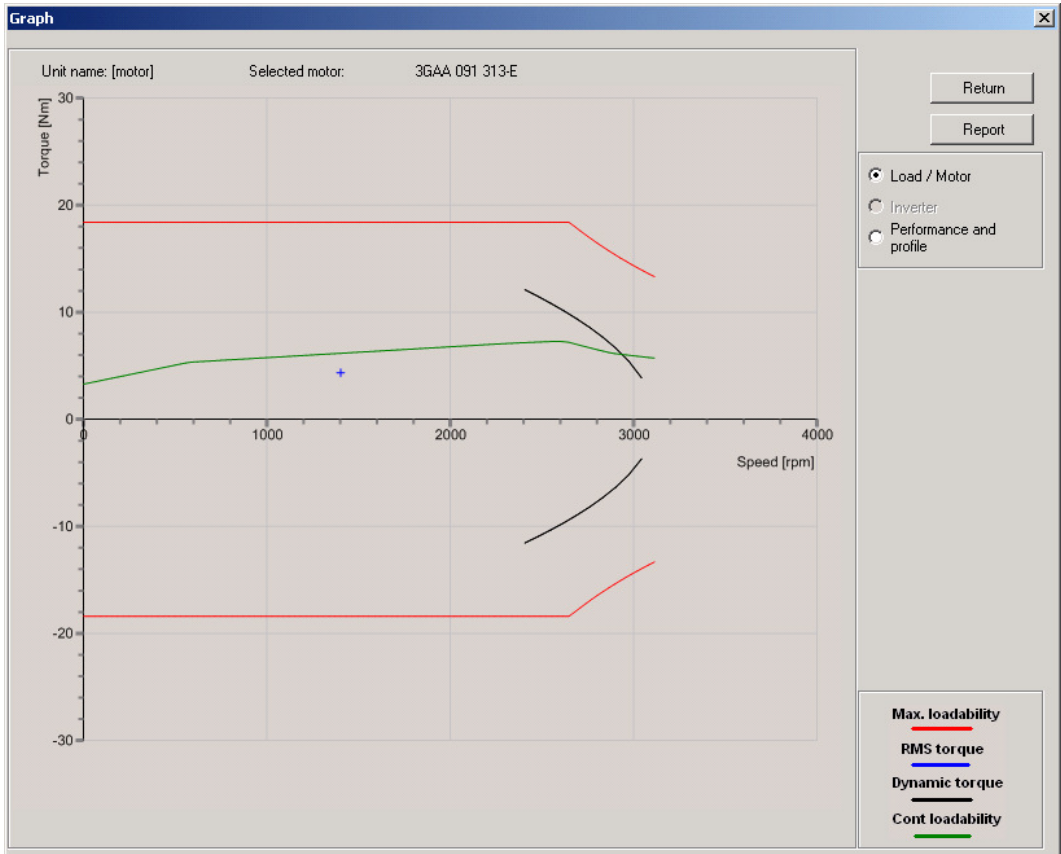


Figure 40. Motor Graph display for Induction Motor

6.5 Drive results

In the **Drive Results** display you can see the results and specification data for **Selection data**, **Specifications**, **Catalogue data** and **Drive losses at RMS speed**.

The selection criteria for a drive are:

- Peak current trajectory must be lower than the max current limit.
- Calculated RMS current must be lower than the nominal current.
- Inverter maximum output power must not be exceeded
- Additionally, the dynamic thermal limit is checked

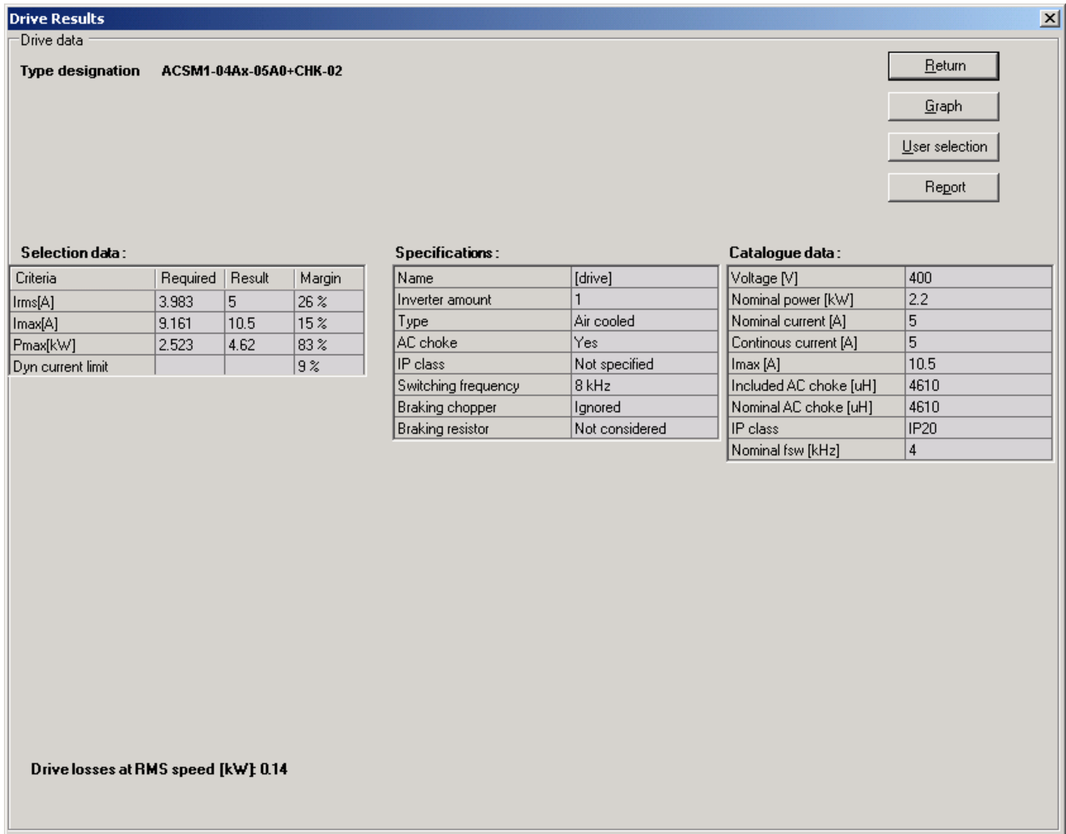


Figure 41. Drive results display

6.5.1 Drive Graph

You can see the drive results also in graphical form (see Figure 42). Current/speed curves define the limits for continuous (green) and intermittent currents (red). The latter current limit depends on drive heatsink temperature, output frequency and switching frequency. Calculated RMS current, actual current trajectory and limits are shown in the drive graph.

Also this graph can have two quadrants.

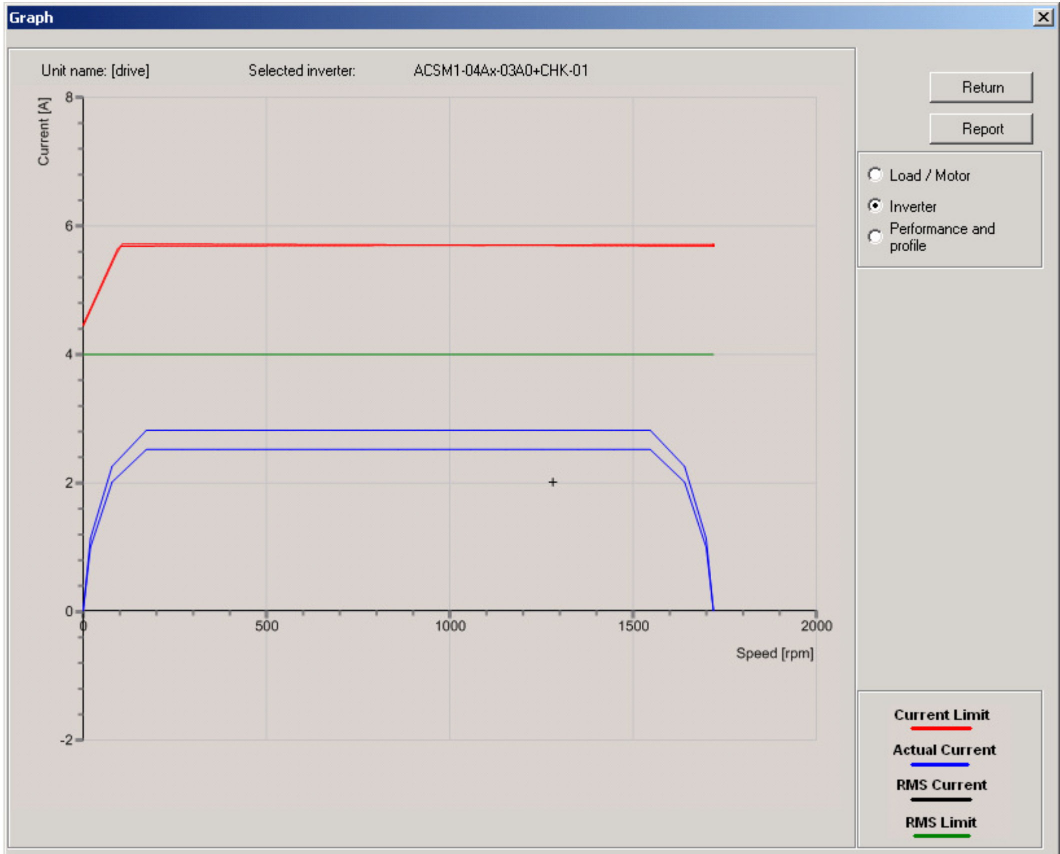


Figure 42. Drive Graph display

Please notice that in this example due to s-curves the acceleration starts smoothly, runs most of the time at 2.4A and will easy up at 1520 rpm. The deceleration will happen with lower current but with the same idea.

6.6 Supply unit results

In the **Supply unit data** display you can see the results and specification data for **Selection data** (Figure 43), **Specifications**, **Catalogue data** and **Supply unit losses**.

The selection criteria for a supply unit are:

- Calculated RMS current must be lower than the nominal current.
- Peak current must be lower than temperature dependant max current limit.
- Additionally, the dynamic thermal current and temperature limits are checked

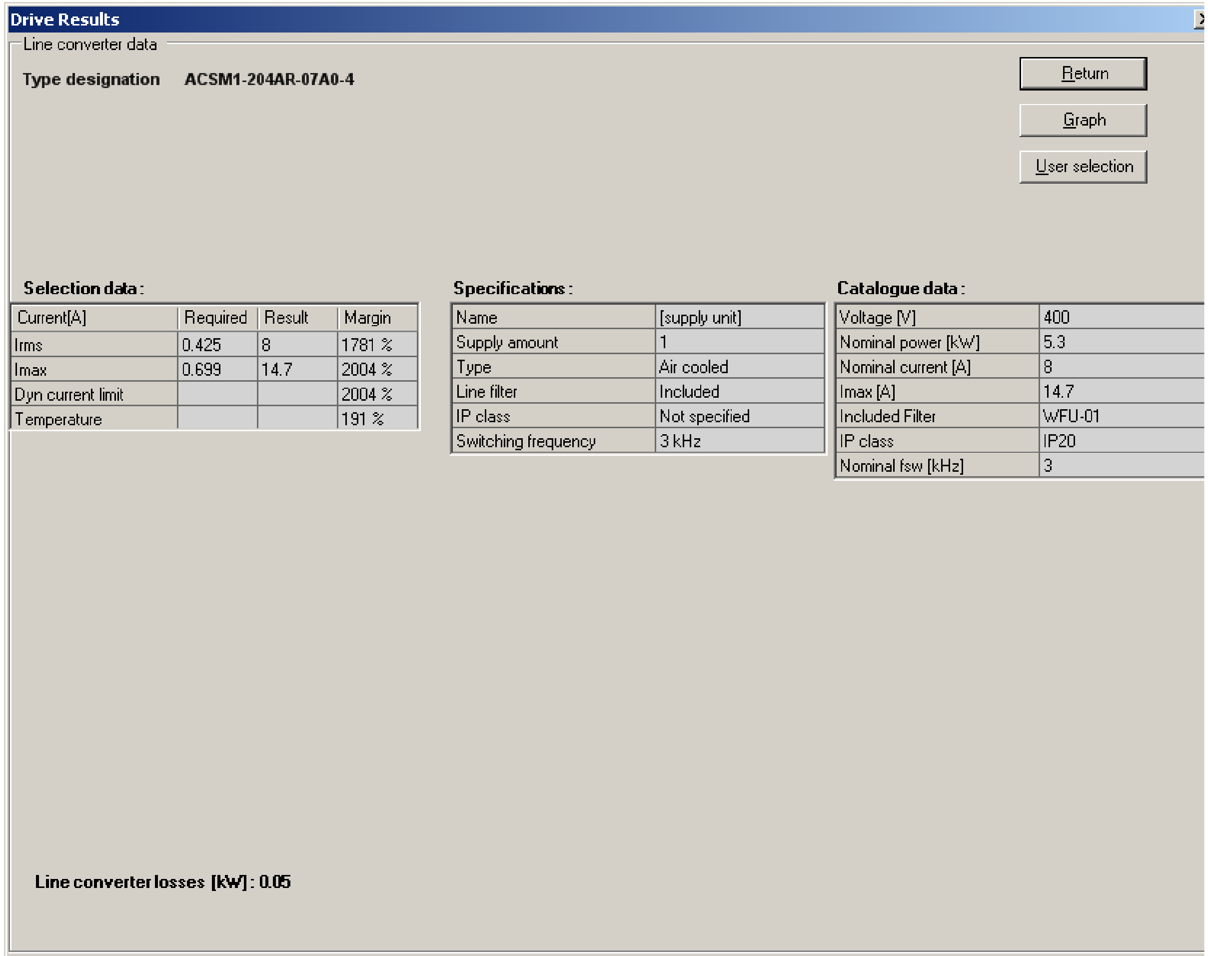


Figure 43. Selection data of supply unit

6.6.1 Supply unit Graph

You can see the supply unit results in graphical form (Figure 44). There the DC-power of supply unit is shown in function of time. The graph illustrates the total DC-power of all inverters connected to that supply unit.

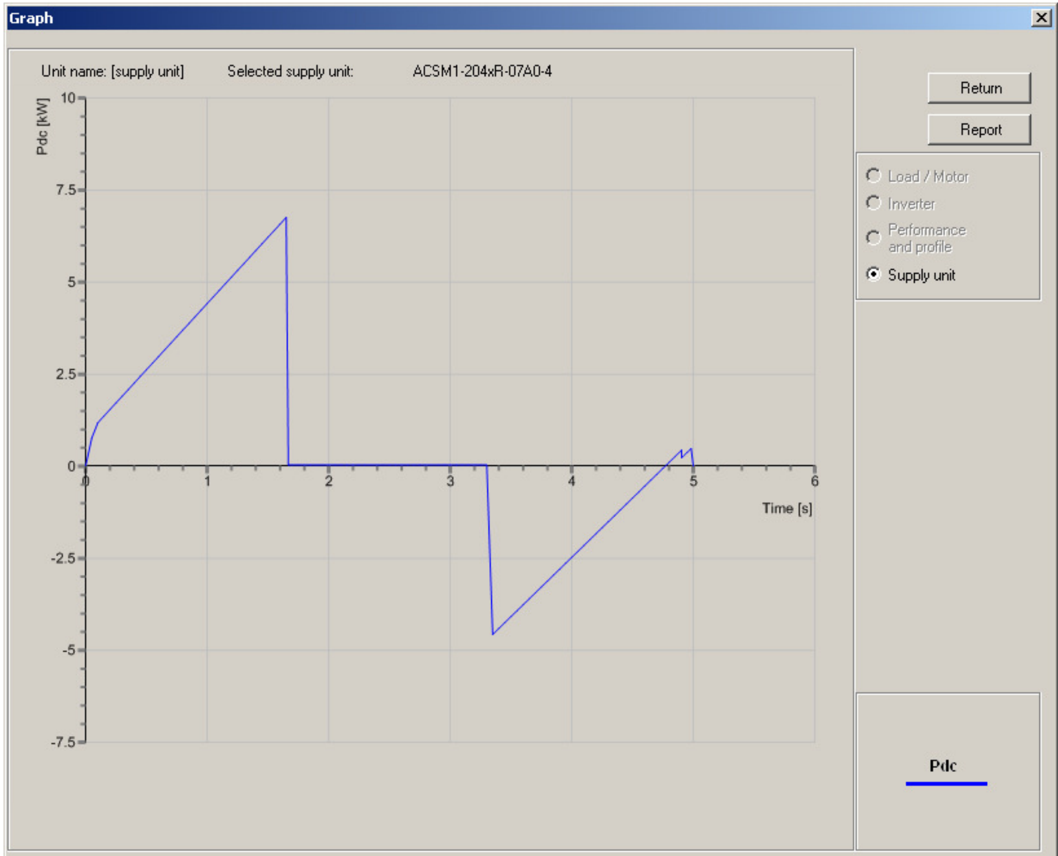
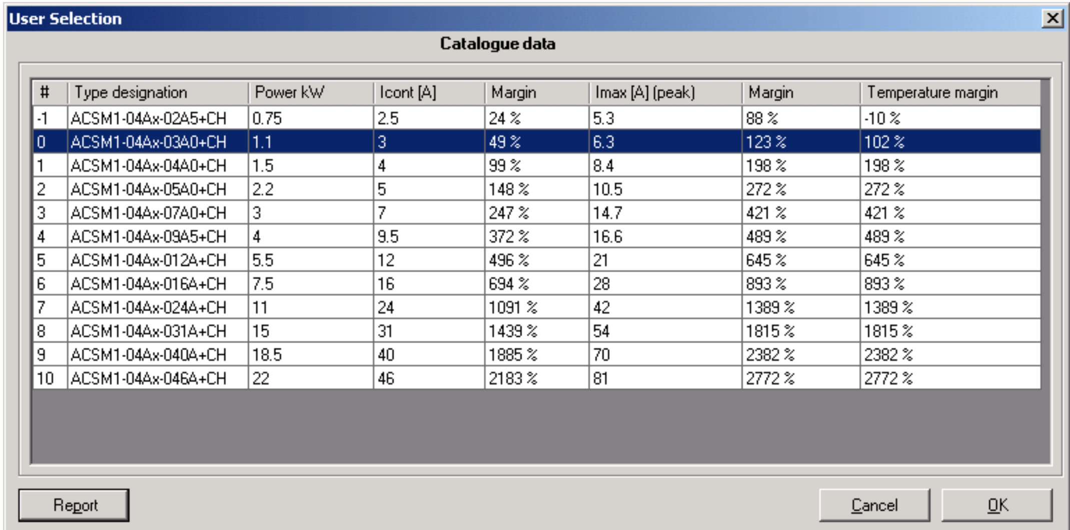


Figure 44. *Supply unit graph display*

6.7 User selection

User selection functionality is a part of the sizing process and the screen with plenty of computed choices is also a part of the results.

In the **User selection** display you can select a smaller or larger unit instead of your current selection (made by the software or by your previous other choice selection). The selected unit has number 0 and its row is highlighted. Smaller units have a negative mark. Larger units have a positive mark. In this table there are some catalogue values and calculated margins to help with the new selection process. In some cases in which the overloads are decisive there are no smaller units in the list.



#	Type designation	Power kW	Icont [A]	Margin	Imax [A] (peak)	Margin	Temperature margin
-1	ACSM1-04Ax-02A5+CH	0.75	2.5	24 %	5.3	88 %	-10 %
0	ACSM1-04Ax-03A0+CH	1.1	3	49 %	6.3	123 %	102 %
1	ACSM1-04Ax-04A0+CH	1.5	4	99 %	8.4	198 %	198 %
2	ACSM1-04Ax-05A0+CH	2.2	5	148 %	10.5	272 %	272 %
3	ACSM1-04Ax-07A0+CH	3	7	247 %	14.7	421 %	421 %
4	ACSM1-04Ax-09A5+CH	4	9.5	372 %	16.6	489 %	489 %
5	ACSM1-04Ax-012A+CH	5.5	12	496 %	21	645 %	645 %
6	ACSM1-04Ax-016A+CH	7.5	16	694 %	28	893 %	893 %
7	ACSM1-04Ax-024A+CH	11	24	1091 %	42	1389 %	1389 %
8	ACSM1-04Ax-031A+CH	15	31	1439 %	54	1815 %	1815 %
9	ACSM1-04Ax-040A+CH	18.5	40	1885 %	70	2382 %	2382 %
10	ACSM1-04Ax-046A+CH	22	46	2183 %	81	2772 %	2772 %

Figure 45. User selection display

7 Printing

This software uses Microsoft Excel for printing. You can use the print and preview options if you have Microsoft Excel 97/2000 or later version installed on your computer.

You can use the printing function for two purposes:

- to export project information to Excel or PDF formats
- to print project information on paper.

To print results:

1. Open the **Print** display by:
    - Clicking the toolbar icon ,
    - Selecting **File > Print** from the menu, or
    - Pressing the **Ctrl+P** short cut key.
2. Select the items to be moved to Excel. You can print a project data sheet, a project technical data sheet or all data sheets for a project (see Figure 46).

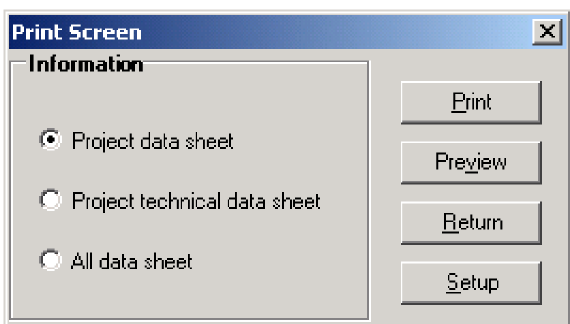


Figure 46. Print display

3. Click **Print** to print the desired information. If you select **Setup**, you can select the printer and print options (**Paper size**, **Source** and **Orientation**).

8 Help

The software's context sensitive Help file contains the same information as this document.

To open the Help file, select **Help > Contents**. For information on how to use the help, select **Help > How to use help**.

Select **Help > About** to view MCSize version information.

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